THE Petroleum Engineer • MARCH 1934 • VOLUME V • NUMBER VI

THE ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY

This Issue Contains

DRILLING AND PRODUCTION

	Page
New Record with 16-Inch Welded Casing By Wallace A. Sawdon	26
Oil Well Pumping in the East Texas Field By J. E. Elliott	27
Elements of Applied Petroleum Production By K. C. Sclater	42
Utilizing a 3000-Pound Pressure in a Clean-Out Job By Wallace A. Sawdon	80

REFINING AND NATURAL GASOLINE MANUFACTURING

United's Myrtis Gasoline Plant Embodies Many New Features By Frank H. Love	22
"Roots" Type Blowers for Pumping Inert Gas By Neil B. Musser	32
Elements of Applied Petroleum Refining By W. L. Nelson	47
Vocational Refinery Mathematics By P. Albert Washer	51
Another Use for Petroleum Coke By J. L. Massie	61

OIL AND GAS TRANSPORTATION

Observations on Modern Methods of Design and Construction of Pipe Lines By R. W. Howe	18
Electrical Mitigation of Pipe Line Electrolysis By R. T. Falkenberg	56
Problems of Heat Control in Diesel Engine Operation By Sam Monroe	77

REGULAR DEPARTMENTS

The Course of Oil	9
Highlights in Oildom	10
Latest Activities in the Oil Fields	12 and 13
Progress of Major Pipe Line Work	14
The Month's Activities in Refining	17
New Petroleum Equipment	62, 65 and 66
Running Tour with Men in the Industry	69
Strange But True	72
Laugh with Barney	70
Trade Literature	82

Meetings

American Petroleum Institute, California District Meeting, Division of Production — April 4, Los Angeles.

Western Petroleum Refiners' Association — April 5 and 6, Excelsior Springs, Missouri.

American Petroleum Institute, Eastern District Meeting, Division of Production—April 6 and 7, State College, Pennsylvania.

American Chemical Society, Twelfth Mid-West Regional Meeting — May 3, 4 and 5, Kansas City, Missouri.

Natural Gasoline Association of America—May 9, 10 and 11, Tulsa, Oklahoma.

International Petroleum Exposition—May 12 to 19, inclusive, Tulsa, Oklahoma.

American Society of Mechanical Engineers, National Petroleum Division—May 14, 15 and 16, Tulsa, Oklahoma.

American Petroleum Institute, Mid-Year Meeting — May 22, 23 and 24, Wm. Penn Hotel, Pittsburgh, Pennsylvania.

American Association of Petroleum Geologists—March 22, 23 and 24, Baker Hotel, Dallas, Texas.

American Petroleum Institute, Fifteenth Annual Meeting — November 12, 13, 14 and 15, Dallas, Texas.

THE PETROLEUM ENGINEER PUBLISHING COMPANY

Tower Petroleum Building :: Dallas, Texas

C. Morris - - - - - *President-General Manager*
J. L. Dwyer - - - - - - - - *Vice-President*
T. J. Crowley - - - - - - - *Vice-President*
W. T. Bryan - - - - - - *Secretary-Treasurer*
W. L. Love - - - - - - *Advertising Manager*
C. R. Barrett - - - - - *Circulation Manager*
K. C. Sclater - - - - - - - - - - *Editor*
Frank H. Love - - - - - - *Associate Editor*

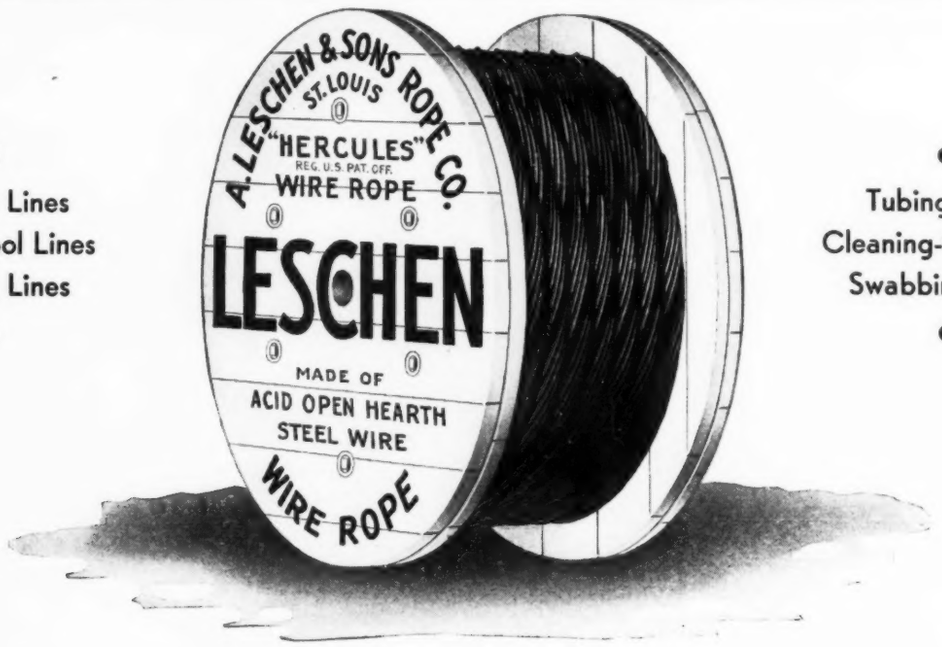
COPYRIGHT—Each issue of the Petroleum Engineer is copyrighted. Any republication of the matter appearing in the magazine, either wholly or in part, is not permitted except by special authorization. SUBSCRIPTION PRICE *—Single copies 15 cents. Domestic and foreign, $1.00 per year, with the exception of Canada, where the price is $1.65 per year.*

MEMBER A. B. C.

NRA MEMBER U.S. WE DO OUR PART

MEMBER A. B. P.

- Rotary Lines
- Cable-Tool Lines
- Casing Lines



- Tubing Lines
- Cleaning-Out Lines
- Swabbing Lines

How Can Old Operating Costs Be Maintained Since Wages Are Increased?

This is a question to which many of us are now seeking an answer.

It seems to be the opinion of some that the way to bring this about is to buy material that is low in first cost, but do you agree with them? After all, are not final results what actually count?

We do not claim that "HERCULES" (Red-Strand) Wire Rope is the lowest first cost rope that can be bought, but we are firm in our contention that it is the most economical heavy duty wire rope that can be used. It will not only do more work for each dollar of its cost, but on account of its longer life, less time will be spent in making replacements; moreover, it can be depended upon, even when extra hard conditions are encountered.

There are reasons, of course, why "HERCULES" is so dependable and long lasting, and we would be glad to have anyone interested in saving money on this item of their equipment write either to us or to our nearest distributor for further particulars.

NRA MEMBER U.S. WE DO OUR PART

Made Only by A. Leschen & Sons Rope Co. Established 1857

ST. LOUIS—5909 Kennerly Avenue

New York . . . . . 90 West Street
Chicago . 810 West Washington Blvd.
Denver . . . . . 1554 Wazee Street
San Francisco . . 520 Fourth Street

Domestic Distributors:

CASEY & NEWTON
Room 901 Century Building
Pittsburgh, Pa.

HILLMAN-KELLEY, Incorporated
2441 Hunter Street
Los Angeles, Calif.

HINDERLITER TOOL COMPANY
Tulsa, Okla.

NORVELL-WILDER SUPPLY COMPANY
Beaumont, Texas

OBBORN MACHINERY COMPANY, Inc.
Clarksburg, W. Va.

PARKERSBURG SUPPLY COMPANY
Parkersburg, W. Va.

NEW UNITED PIPE AND SUPPLY COMPANY
Charleston, W. Va.

Export Distributor:

CONTINENTAL EMSCO CO., Inc., 19 Rector St., New York, N. Y.
Branches: Buenos Aires — London — Ploesti

The Course of Oil

By K. C. SCLATER

Crooked Holes and Subsurface Boundaries

When the practice of surveying drilling wells to determine their deviation from the vertical came into general use several years ago, it marked a new era in development and production practice. The geologist and the petroleum engineer now obtain accurate measurements on the depth and position of the bottom of the hole, from which information they are enabled to correlate well data and to analyze subsurface conditions more closely than ever before. Other advantages have accrued in deep wells by the elimination of crooked holes. A crooked hole may cause excessive wear on equipment and make pumping by orthodox mechanical means prohibitive.

Another phase of the crooked-hole problem that now looms important, and one that has not caused any real trouble until recently, is the legal status of a crooked hole. At the height of the Seminole development the crooked-hole problem attracted wide attention among producers in that field. For one thing, it made a substantial change in the apparent geology of the field. It also caused many operators to have misgivings about the legal complications that might develop from possible disputes between offsetting operators regarding drainage of oil and gas from their properties.

When a well is drilled crooked, whether intentionally or not, the many possible legal complications that can develop are obvious. Only recently a deep well in California has been surveyed and a court order to determine whether and how far the well has penetrated beyond vertical boundary lines of adjacent properties. This is the first survey ever made under court order and the results of the survey the first ever presented as evidence in court. A well that is drilled crooked and penetrates the vertical boundaries of offsetting properties may give rise to serious dispute, especially if efforts are made to enforce the cubical content theory in law and practice. If such a theory is vigorously enforced in practice a change in the whole picture of subsurface rights will result that will be a radical departure from the free rights recognized under the law of capture. Perhaps the day is near when it will be required, unless offset operators agree otherwise, to drill each well entirely within the vertical boundaries of the lease in which the well is located.

Drilling Activity Increasing

Reserves of oil in the United States may not be so great as is commonly assumed. Over-production of oil during the last few years has probably been responsible for assuming that the reserves of oil were ample for many years to come. Competent observers assert, however, that known oil reserves in the United States are sufficient for only a few years.

If the present great experiment of controlling production succeeds, the national and state government machinery now set up for this purpose may become permanent. Progress is being made in making legal statutes for better regulation of the oil industry conform with sound engineering principles. Development of uniform production regulations in recent years has been quite rapid and may soon be adequate to maintain stabilization within the oil industry. Irrespective of whether or not the oil reserves of the United States are ample, it is evident that regulation of some sort is necessary to keep supply and demand within reasonable balance. When this is accomplished stability will be assured.

With the signing of the three State oil bills in Texas this month, the running of hot oil in East Texas, it is predicted, will soon cease. This will remove one of the sore spots that has threatened at times to undo all the good that has been accomplished toward recovery since the code was put into effect.

With these facts in mind confidence is expressed by the majority of oil men that under the code the development of new fields will be kept within reasonable bounds and the search for new reserves of oil must continue. Wildcatting is encouraged under the code. These considerations, and the fact that the Oklahoma City field is on the decline, have spurred operators in their search for new fields in Oklahoma. Their efforts are being awarded; several new fields have been discovered in recent weeks. Drilling activity in that State has taken on new life and producing operations are also taking on a healthy outlook. It is quite evident that Oklahoma has no intention of losing its prestige as a leading oil-producing State. Activity similar to that in Oklahoma is evident in other potential oil-producing areas of the country.

Court Sanctions Co-operative Development

An action that favors the co-operative development of oil pools has recently been decided by the Supreme Court of the State of New Mexico. In the Hobbs field, conflict arose regarding the development of certain leases that involved the interests of the royalty owners. It was held by the court that in purchasing the mineral and royalty interest subject to the lease, all royalty holders were bound by the provisions of the lease and that although the tracts were non-contiguous, the terms of the lease were applicable and that irrespective of the location of the producing well or wells, all royalty owners should share in the royalties in proportion to the amount that the acreage owned by each bears to the entire lease acreage.

This decision in effect sanctions and upholds co-operative development of oil pools where the lease agreement provides that all royalties that accrue shall be treated as a unit and be divided among and paid to the separate owners in the proportion of his acreage to the entire lease acreage. The leases in question happen to comprise one of the most productive tracts in the Hobbs pool. This decision conforms with good drilling and production economics—besides, it should redound to the benefit of the royalty owners.

« « « HIGHLIGHTS IN OILDOM » » »

Texas Decision Blow to Oil Code

When Federal Judge Randolph Bryant ruled recently that penalties under the NRA petroleum code could not be applied against oil companies that had failed to sign the code and were engaged only in intrastate commerce, it was looked upon as being a severe blow to the National Recovery Act and as an end to the Federal Government's participation in proration enforcement, provided, of course, the decision were permitted to stand. The ruling was made in the cases of the Amazon Petroleum Company and others against the Texas Railroad Commission, and the Panama Refining Company and others against A. D. Ryan, an Interior Department agent. The decree signed by Judge Bryant enjoined federal authorities from enforcing any rule or regulation promulgated under the National Recovery Act insofar as it applied to production, refining, storage or transportation of petroleum or its products in intrastate commerce. The court ruling also prohibited federal agents from going on or about the premises of the plaintiffs or molesting them in the conduct of their business by reason of the provisions of the NRA or regulations promulgated under them. Steps were taken immediately to bring the case before the United States Supreme Court for decision. A federal grand jury returned indictments on accusations that Judge Bryant had ruled invalid in order that a direct appeal could be made to the Supreme Court, thus avoiding a long delay that would result if the case went through the Court of Appeals at New Orleans. When Judge Bryant, on February 27, sustained a demurrer to one of five indictments against men who had been charged with conspiracy to install an illegal by-pass on an East Texas lease, all legal obstacles to a Supreme Court decision on the constitutionality of the petroleum code, as applied to intrastate commerce, was cleared away. Charles I. Francis, special assistant to the attorney general, left for Washington immediately to present the appeal case before the high court.

●

Texas Oil Bills Become Law

Three bills, designed to aid the Railroad Commission in its enforcement efforts, have been passed by both branches of the Texas Legislature and signed by Governor Ferguson. One bill raises from one-tenth to one-eighth of a cent per barrel the tax levied on crude oil to provide funds used by the Railroad Commission in regulating the oil fields. Another brings refineries under the supervision of the Commission and is calculated to stop important leaks of "hot oil" into the markets. The third bill is to reconcile penalties in previously enacted measures. This bill imposes a misdemeanor penalty of a fine of $500 or not over six months in jail, or both, for petty offenses, and makes a felony of withholding information or violating conservation orders of the Railroad Commission, punishable by two to four years imprisonment. It also names responsible persons where a partnership, firm or corporation is guilty of violation, in such cases the president, chief managing director and participating officials being the ones to receive criminal punishment.

U. S. Oil Output Boosted

Effective March 1, the oil allowable for the United States was increased 99,800 bbl. by an order of Secretary Ickes. This order modified a previous one of Secretary Ickes, made December 20, which set allowables for January, February and March at 2,183,000 barrels.

●

116 Taxes Paid By Oil Industry

The American Petroleum Industries Committee has compiled statistics disclosing that the petroleum industry currently is paying 116 taxes. Of these, 24 are paid to the federal government, 68 to state governments, five to county governments and 19 to municipalities. The industry's tax bill is approximately $1,000,000,000 per year. Taxes are applied to virtually every operation and product from well to market.

●

Russia Buying Mid-Continent Natural Gasoline

Soviet Russia has purchased two cargoes of Mid-Continent stabilized natural gasoline, and is reported to be contemplating the acquisition of six to eight additional cargoes during 1934. The first movement took place early in January and was for an 18- to 22-lb. product from Oklahoma and Texas plants. Agents of the Russian oil administration say that deflation of the American dollar has made it attractive for them to purchase gasoline and other supplies in this country.

●

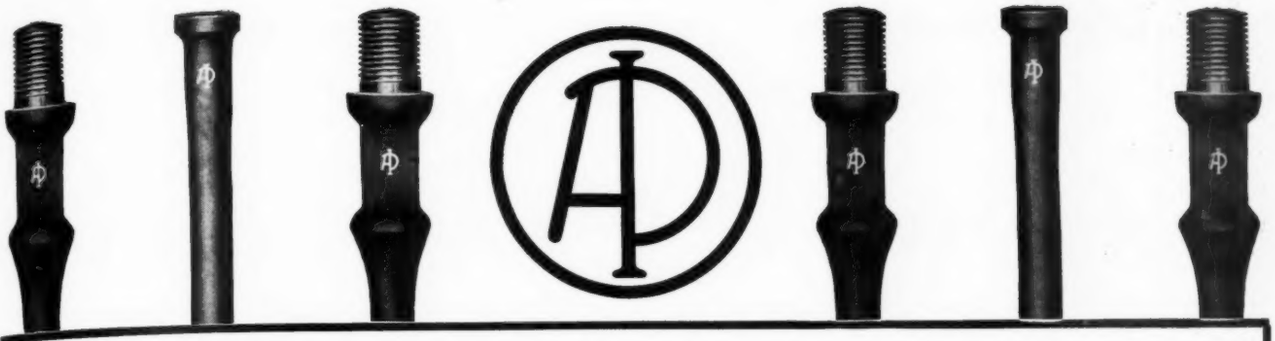
Program for New Pool Approved

A program of development for the new Lucien pool of southwestern Noble County, Oklahoma, has been approved by Secretary Ickes, national oil administrator. The plan, drawn up and submitted by operators, emphasized the necessity of drilling but one well to each 40 acres. That policy was upheld, with the provision that any operator feeling he was not being justly served could file a protest with the petroleum administrative board and a hearing held and his complaint considered.

●

Court Rules City Can Demand Surety Bonds

The Oklahoma Supreme Court has handed down a ruling that the city of Oklahoma City can require oil companies drilling wells within the city limits to file surety bonds for $200,000, renewable at the end of a year at $50,000 in case the well has been completed. The opinion was written by Justice Thomas G. Andrews in the appeal cases by the C. C. Julian Oil and Royalties Company and the Hud Oil and Refining Company against the city of Oklahoma City. Attorneys for the oil companies had contended that the state legislature had conferred upon the corporation commission exclusive power to enact rules and regulations governing the drilling for oil and gas. The court ruled, however, this did not tend to deprive the legislature of power to delegate to the cities the powers set by law.



ANNOUNCING "OILWELL'S" NEW

GRADE "A"

THE IMPROVED "TRIPLE TREATMENT"

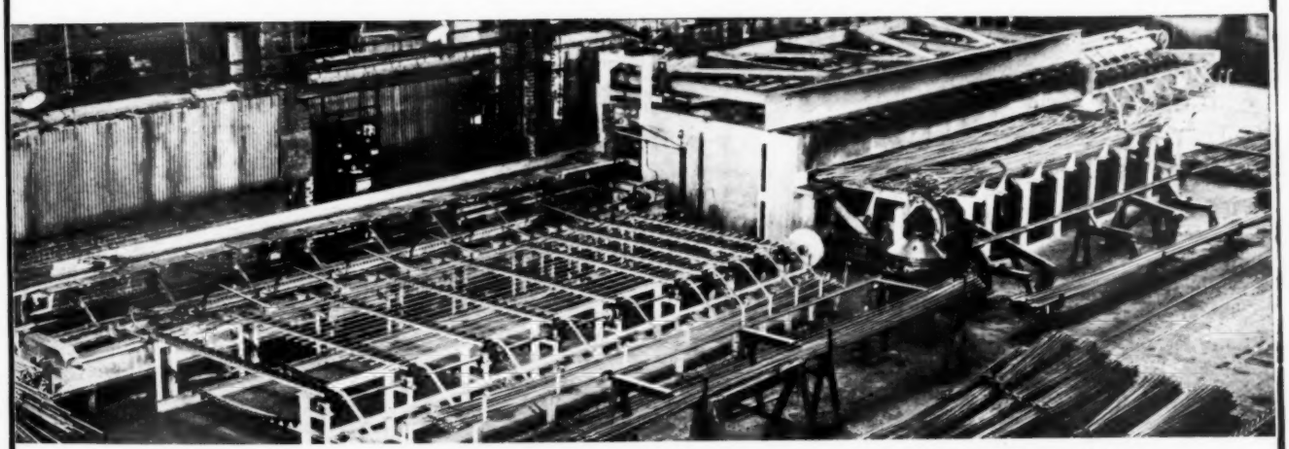
SUCKER RODS

AND PULL RODS

"OILWELL" GRADE "A" RODS ARE FULLY HEAT-TREATED, i. e., NORMALIZED, QUENCHED, AND DRAWN FROM END TO END.

"OILWELL" ONLY HAS THESE NEWLY DEVELOPED FACILITIES WITH "LABORATORY PRECISION CONTROL" TO PROCESS AND "PROOF-TEST" SUCKER RODS AND PULL RODS, INSURING UNIFORM PHYSICAL PROPERTIES THROUGHOUT THEIR ENTIRE LENGTH.

"PROOF OF QUALITY BY IMPROVED SERVICE"



"OILWELL'S" NEW HEAT-TREATING FURNACE AND AUXILIARY EQUIPMENT

NRA MEMBER U.S. WE DO OUR PART

Apply at nearest "OILWELL" store or office for detailed information.

OIL WELL SUPPLY CO. *Branch Stores in all Oil Fields*

SUBSIDIARY OF UNITED STATES STEEL CORPORATION

2495

"OILWELL"

LATEST ACTIVITIES IN THE OIL FIELDS

INTEREST in Oklahoma has shown a considerable increase within the last few weeks by the discovery of several new pools. The Fitts area, apparently, is obtaining the most play. The Manahan Drilling Company and Associates brought in the well that extended the southern Pontotoc County pool. This semi-wildcat found the McAlester (Booch) sand at 1725 ft., with first oil at 1735 feet. Pipe was set at 1764 feet.

No. 1 Fouts of the Amerada Petroleum Corporation and Stanolind Oil and Gas Company, near Langston, in eastern Logan County, opened a new field when the Wilcox sand was found at 5097 to 5102 feet. After flowing by heads for several hours the well had to be shut in when a fishing job developed because of gas. Later, with the hole cleaned out sufficiently, a test showed the oil to be of 47.5 gravity.

The linking together of the old Burbank pool with the Burbank extension area to the south became more assured when the third well in the field started flowing February 28. Known as the Manahan Drilling Company and others No. 1 it made 138 bbl. the first hour. Bartlesville sand was topped at 2725 ft. and the well drilled to a total depth of 2754 feet.

A new field also has been found at Newalla, where the Spring Rose Drilling Company and Watchorn Oil and Gas Company No. 1 R. J. Edwards came in after being acidized. The Hunton lime pay is at 6025 to 6069 ft. and oil men estimate the well as good for 100 bbl. an hour.

Activity in the Lucien area southwest of Perry, in Noble County, seems due to be revived, as the Carter Oil Company apparently has found the rich sector of the area. Carter's No. 1 Webber, the most southwesterly producer in the field, and which was a small well in the Wilcox sand, drilled ahead and found the second Wilcox at 5122 ft. and the pay at 5195-5205 feet. It made 3567 bbl. in the first 18 hours.

•

West Texas has been the scene of much activity in recent weeks, both in wildcat areas and proven fields. The Wichita Falls district has been the leader in this respect. The productive area of the James pool in Young County was extended one-half mile to the north when Pitzer & West's No. 2 Morrison swabbed 125 bbl. after acid treatment at 3839-3965 feet.

•

Tide Water Oil Company and Texas Seaboard Oil Company opened a new field in the Cayuga area of northwestern Anderson County, Texas, when their No. 1 Edens was brought in at 4088 feet. On the initial test the well flowed 42 bbl. in 30 minutes after being swabbed. The oil is 30.2 gravity and from the Woodbine sand.

•

With the completion by the Union Sulphur Company of its No. 1 Barbee, flowing 500 bbl. daily, a new deep sand has been opened in the northwest flank extension of the East Hackberry Dome, Cameron Parish, Louisiana. The bottom of the hole is at 7,598 ft., making it the deepest commercial producer on the Louisiana coast.

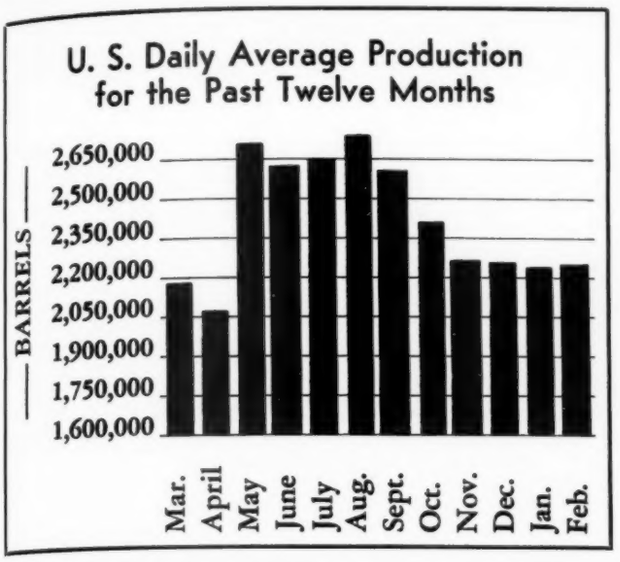
AVERAGE CRUDE OIL PRICES

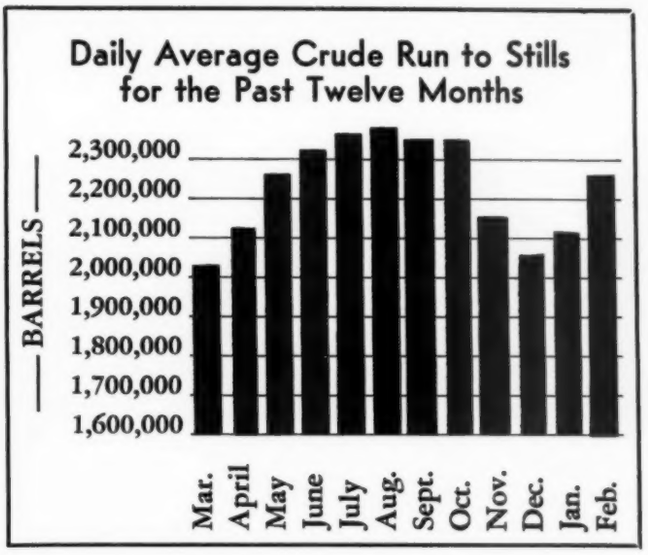
California		Arkansas	$ .70
Playa Del Rey	$ .90	Louisiana	
Coalinga	.81	North Louisiana	.95
Long Beach	1.00	Gulf Coast	1.04
Signal Hill	1.12	Illinois	1.12
Montana	1.35	Kentucky	1.17
Wyoming	1.00	Indiana	1.12
Colorado	1.00	Ohio	
New Mexico	.75	Lima	1.30
Texas		Wooster	1.15
North Central	.95	Michigan	1.02
Panhandle	.83	Pennsylvania	
West Texas	.70-.75	Bradford	2.45
Gulf Coast	1.04	Southwest	2.12
Darst Creek	.87	Corning	1.20
East Texas	1.00	West Virginia	2.07
Kansas	1.00	Canada	2.10
Oklahoma	1.00		

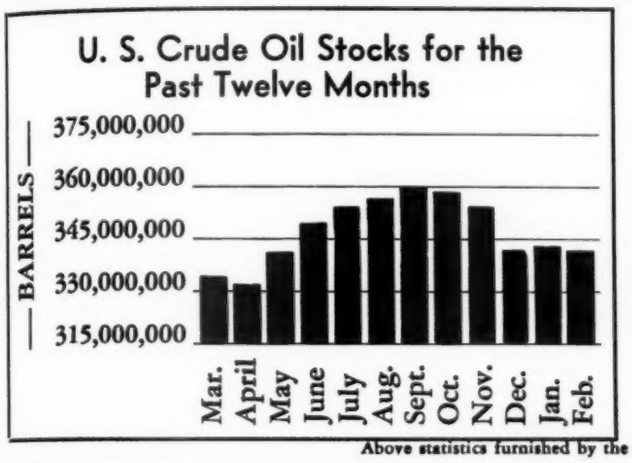
DAILY AVERAGE CRUDE OIL PRODUCTION

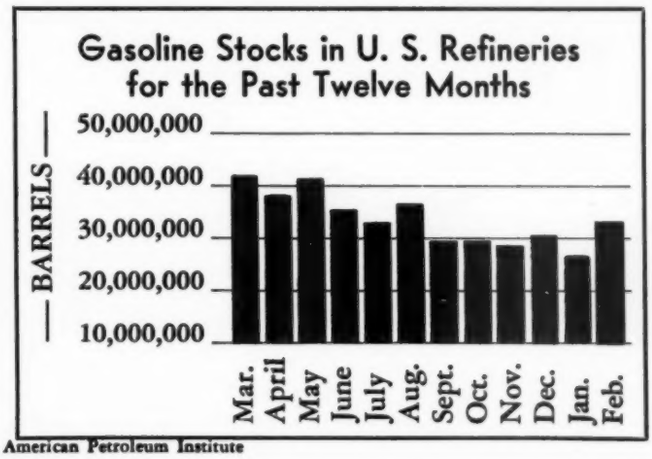
(Figures in Barrels)
Furnished by A.P.I.

	Federal Agency Allowable Effective Jan. 1	W'k Ended Feb. 24 1934	W'k Ended Jan. 27 1934	W'k Ended Feb. 25 1933
Oklahoma	446,600	440,400	467,350	521,500
Kansas	110,000	109,900	107,450	108,550
Panhandle Texas		52,300	42,600	47,800
North Texas		55,000	52,900	46,550
West Central Texas		26,700	24,750	25,650
West Texas		128,700	129,250	157,750
East Central Texas		43,100	42,950	59,450
East Texas		415,200	396,000	302,400
Conroe		52,900	47,700	22,250
Southwest Texas		43,100	44,050	50,350
Coastal Texas (Not incl. Conroe)		111,750	110,750	106,100
TOTAL TEXAS	884,000	928,750	890,950	818,400
North Louisiana		28,750	27,800	29,000
Coastal Louisiana		44,350	45,700	33,150
TOTAL LOUISIANA	69,300	73,100	73,500	62,150
Arkansas	33,000	31,250	32,100	31,950
Eastern (Not incl. Michigan)	94,200	92,650	98,600	91,000
Michigan	29,000	28,350	23,550	13,850
Wyoming	29,000	30,850	29,650	31,550
Montana	6,800	5,900	5,350	5,600
Colorado	2,300	2,800	2,850	2,650
TOTAL ROCKY Mt. STATES	38,100	39,550	37,850	39,800
New Mexico	41,200	41,600	41,500	37,100
California	437,600	440,500	449,900	468,300
TOTAL U S.	2,183,000	2,226,050	2,222,750	2,192,600









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for February, 1934

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas									
East Texas	239	237	254	54	240	3600	2	40	Rotary
Duval County	29	24	27	1	16	2300	2	22	Rotary
Conroe	19	17	17	2	16	5200	2	38	Rotary
Refugio County	8	8	13	5	13	3000-7400	3 or 4	40	Rotary
Oklahoma									
Oklahoma City	3	3	3	14	22	6500	3	39	Rotary
Kansas									
McPherson County	17	14	12	6	35	2900-4300	2	38	Rot.-Cab.
Ellsworth Arch	15	11	21	18	49	3300	4	37	Cable
Harvey County	7	7	6	4	16	3450	2 or 4	37	Rot.-Cab.
California									
Kettleman Hills	0	0	5	7	25	8300	3 or 4	40	Rotary
Long Beach	6	6	12	7	18	7000	3	26	Rotary

Field Activities by States for February, 1934

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1933 (In Barrels)
	February	January	February	January	February	January	February	January	February	January	
Arkansas	8	3	3	0	2	7	6	9	32	40	11,682,100
California	21	30	21	28	22	45	39	39	146	145	173,126,800
Colorado	4	0	3	0	....	....	3	5	47	49	954,900
Illinois	1	0	0	0	....	....	2	2	9	11	4,250,000
Indiana	16	34	8	21	....	....	2	4	33	32	730,000
Kansas	58	62	42	37	44	77	33	28	125	143	41,927,700
Kentucky	8	4	5	2	....	....	3	2	57	48	4,610,000
Louisiana	49	55	25	30	34	88	50	43	180	193	24,487,800
Michigan	24	43	19	30	20	37	94	108	103	117	7,790,800
Mississippi	2	3	0	1	....	....	2	6	15	18	Gas Prod.
Montana	4	7	4	6	....	....	4	6	49	43	2,128,700
New Mexico	3	10	2	5	....	....	6	2	50	58	13,086,600
New York	....	3	....	3	....	....	3	3	16	16	3,150,000
Ohio	80	91	64	70	....	....	20	24	125	139	4,300,000
Oklahoma	114	140	89	101	107	153	103	109	366	374	181,133,200
Pennsylvania	39	110	35	110	....	....	34	38	114	110	12,690,000
Texas	606	752	469	577	558	713	210	189	925	940	396,993,600
West Virginia	21	56	18	50	....	....	18	20	72	70	3,825,000
Wyoming	2	4	1	3	....	....	9	5	60	65	11,211,000
Total	1060	1407	808	1074	787	1120	641	642	2524	2611	898,078,200

PROGRESS OF MAJOR PIPE LINE WORK

A REPORT of the Interstate Commerce Commission shows that interstate pipe line mileage at the close of 1929 was 85,796 miles. This figure does not include gathering lines or lines operating within the state. It was estimated by the A.P.I. during the spring of 1933 that there were 116,000 miles of trunk lines in the United States.

●

A natural gas line to run from the Jackson, Mississippi, field northward across the state to Muscle Shoals, Alabama, is being planned by the Independent Utilities Company of Jackson. The line would be more than 200 miles in length. Franchises have been obtained from various towns en route, it is stated.

●

The Stanolind Pipe Line Company recently completed laying approximately 19 miles of 10-in. pipe in three short loops along its main line south of Mexia to Hufsmith, Texas.

●

Sinclair-Prairie Pipe Line Company will lay an oil line into the Haury pool of Reno County, Kansas, to provide a better outlet for production from that field, it is reported. The field now has ten wells with a total daily potential of 3,645 barrels. A pumping station will be built to boost the oil to the Hollow pool, where it will connect with the company's main line.

●

The Illinois Pipe Line Company has completed the 6- and 8-in. gas line between Medicine Bow, Wyoming, and Dutton Creek, a distance of 22 miles. The new line will serve Medicine Bow with natural gas. At Dutton Creek it connects with the line converted last year from an oil carrier to serve natural gas in Laramie, Wyoming. The Ohio Oil Company, parent organization of the Rocky Mountain Gas Company, serving Laramie, recently completed a 17,000,000-cu. ft. gas well in the Allen Lake structure, and it is to give the company an outlet for this gas that the new carrier was built.

●

A project to construct a natural gas pipe line extension from Williston, N. D., to Minot, N. D., is being considered. The extension would cost approximately $1,523,000. Under the present plan it will be a federal loan proposition by the city, with the Montana-Dakota Power Company operating and paying costs out of proceeds of gas sales.

●

The Arizona Public Works Board has made application to federal authorities for a loan of $64,000 to construct a natural gas line extension to serve Mesa, Arizona. Gas supply would come from the new main line of the Western Gas Company between Douglas and Phoenix. The lateral to serve Mesa would be approximately 25 miles long.

●

The General Utilities Company, with headquarters in Kansas City, Mo., has completed a 16-mile, 4-in. pipe line to supplement the gas supply of The Liberty (Mo.) Gas and Service Company system, subsidiary of the General Utilities Company. The new line originates in the Plattsburg field of Clinton County and terminates in the Smithville field, Clay County, from where Liberty has been provided its gas supply.

●

The Victoria Gas Company, Victoria, British Columbia, subsidiary of the British Columbia Railway Company, Vancouver, plans to extend its line south of Windsor Road in Oak Bay through to Uplands. Cloverdale, Esquimalt and Saanich also probably will be included in the extension.

●

A natural gas line to connect Minneapolis and St. Paul with the Montana fields, and which would cost $17,000,000, is being considered, according to an announcement by C. I. Tenney, president of the Willmar, Minnesota, Gas Company, controlled by the Continental Public Utilities Corporation, Minneapolis, of which Mr. Tenney is a director. Application for a loan to finance construction has been made to the federal government.

●

Congressman Wesley E. Disney of Tulsa, Okla., has introduced in the House of Representatives a bill which, if passed, will grant to the Phillips Pipe Line Company an easement for rights-of-way for a gasoline pipe line across the Jefferson Barracks Military Reservation at St. Louis, Missouri.

●

The El Paso Natural Gas Company is laying a 20-mile transmission line from the southeastern part of Eddy County, New Mexico, to the town of Loving.

●

The Coltexo Corporation, of Monroe, La., has placed an order with the Naylor Pipe Company, Chicago, Ill., for approximately 17 miles of 16-in. O.D. Naylor Spiralweld Toncan iron pipe, Victaulic coupled, for a gas line in the Panhandle of Texas.

●

The Oklahoma Pipe Line Company, a subsidiary of the Standard Oil Company of New Jersey, has completed a 4-in. line laid from the Lloyd pool east of Ada, Okla., to the Fitts pool, a distance of ten miles.

●

The United Gas Public Service Company started work in January on a combination 10- and 16-in. natural gas line from the Conroe field to connect with its main line at a point south of Cleveland, Texas. The line will be approximately 25 miles long.

●

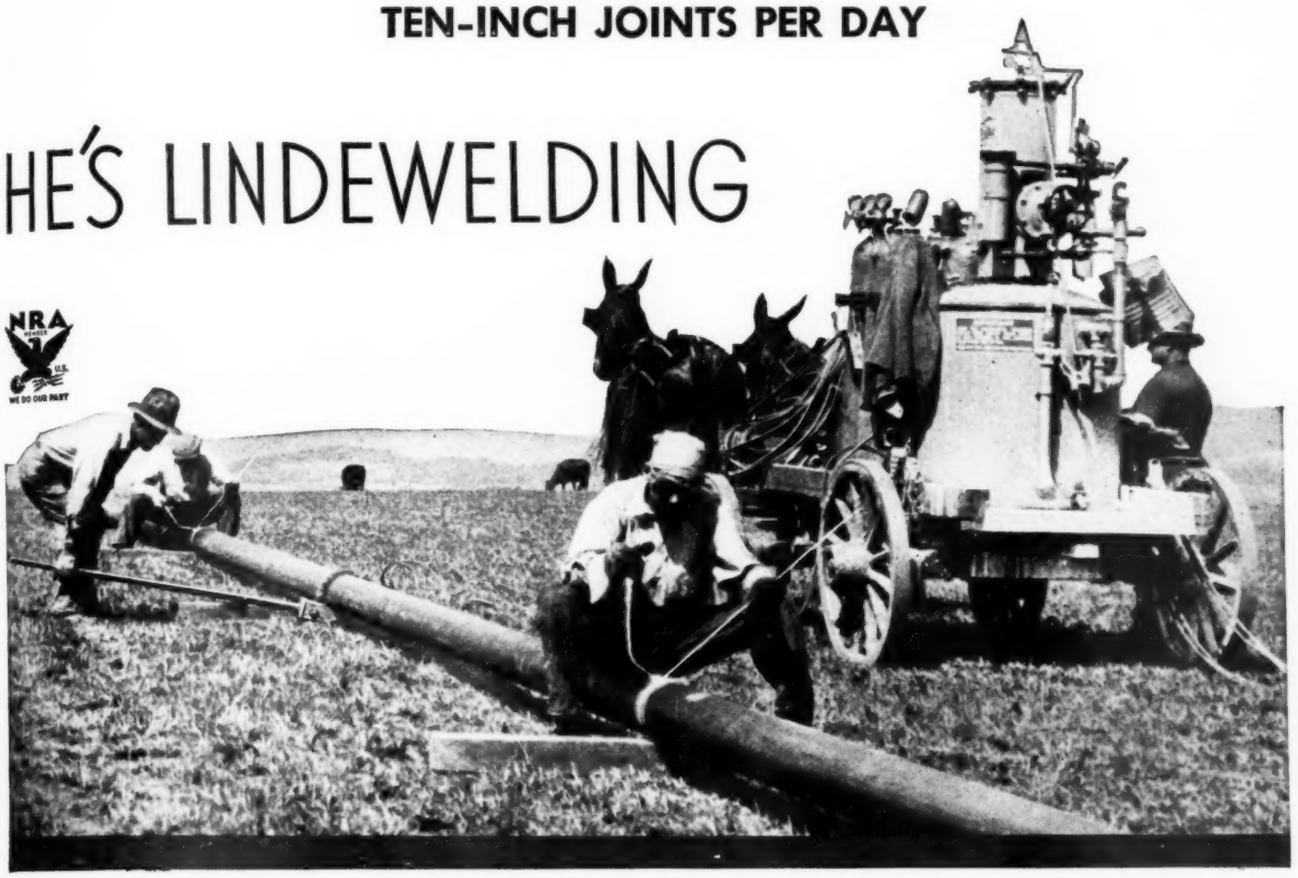
The Oklahoma Western Gas Company is planning an 8-in. natural gas line from the Sayre field to Bridgeport, Oklahoma. Six- and 4-in. laterals will supply other towns. A PWA loan is being sought to finance the project.

WHEN A WELDER

Makes 42

TEN-INCH JOINTS PER DAY

HE'S LINDEWELDING



LINDEWELDERS on a 200-mile 10-in. oil line in East Texas averaged from 35 to 42 Lindewelds a day each. Every joint tested strong and tight.

Lindewelding makes records like this because it is a better and faster method of oxy-acetylene welding. It reduces welding time 50 to 67 per cent. and reduces consumption of welding materials 25 to 50 per cent.

Lindewelding can be done with an ordinary blowpipe or with special apparatus which makes the welding almost automatic and further increases its speed. Experienced welders quickly master Lindewelding technique, and beginners learn it more rapidly than other methods.

Procedure Controls for Lindewelding are available to all users of Linde Oxygen as a part of Linde Process Service. If faster welding, stronger joints, and lower costs would mean bigger profits this year, ask our nearest district office for complete information today.

Study Lindewelding Technique in this Motion Picture

Our motion picture, "The Lindeweld Process for Pipe Line Construction," shows every detail of Lindewelding technique, which differs from neutral flame welding technique in that it employs a special rod, a special flame adjustment and the "backhand" method of blowpipe manipulation. It reveals the actual steps in making a Lindewelded joint. Pipe line officials and welding or engineering societies may borrow this picture free of charge by writing to any Linde District Office. It is furnished in 16 mm. and 35 mm. safety film.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants · UCC · 627 Warehouse Stocks

IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO

District Offices

Atlanta	Detroit	New York
Baltimore	El Paso	Philadelphia
Birmingham	Houston	Pittsburgh
Boston	Indianapolis	St. Louis
Buffalo	Kansas City	Salt Lake City
Chicago	Los Angeles	San Francisco
Cleveland	Milwaukee	Seattle
Denver	Minneapolis	Tulsa

LINDE OXYGEN · PREST-O-LITE ACETYLENE · OXWELD APPARATUS AND SUPPLIES · UNION CARBIDE

ABERCROMBIE

RED BALL SERVICE

This CUT and PULL Tool has definitely given us in 8 months the same prestige on Inside Recovery jobs that we have enjoyed for 14 years on regular pipe cutting service.

7 patents give Abercrombie the exclusive right to use a combination cut and pull tool. . . . . .

RED BALL CUTTING SERVICE

J. S. Abercrombie Co.

21ST FLOOR GULF BLDG.
HOUSTON - TEXAS

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refining Capacity Operated

Eastern Division, 73.4 Per Cent **Central Division, 67.9 Per Cent** **Western Division, 45.2 Per Cent**

THE Sunray Oil Company has contracted for a 1200-bbl. Dubbs cracking unit to be built at the company's refinery at Allen, Oklahoma. The unit will be constructed by the Foster Wheeler Corporation, and will operate on the full-flashing system, cracking topped crude, fuel oil or gas oil, as occasion may require. The Sunray plant has a capacity of approximately 6,000 bbl. per day.

●

The Texas Oil Products Company is installing a viscosity breaker type cracking unit in its Gladewater, Texas, plant, which it is expected will be in operation by April 1st.

●

The Rice Ranch Oil Company has announced plans for the building of a cracking unit at the company's Santa Maria, Calif., plant. The announcement was made by George W. Lichtenberger, president.

●

B. J. Skinner, of Grand Rapids, Michigan, and associates are formulating plans for the construction of a refinery at Alma, Michigan, near the Porter pool in the Mount Pleasant area. The plant will be erected by the Midwest Refining Company, a new corporation recently formed by Mr. Skinner.

●

A 1000-bbl. topping and lube plant is being built at Haughton, Louisiana, east of Shreveport, by Oil Refineries, Inc. It will operate on Caddo crude. Ampco, Inc., of Dallas, Texas, is doing the construction work and the plant will be ready about April 1st.

●

Olsen Refineries, Ltd., headed by Lars R. Olsen, has built a refinery in South Edmonton, Canada, with a capacity of 1000 bbl. a day.

●

The Exchange Petroleum Corporation is adding an 800-bbl. pipe still and making other improvements to its plant at Albany, Texas.

●

The Spartan Refining Company, Inc., Shreveport, Louisiana, has completed the installation of two new Gyro cracking units. An unusual feature of the plant is a polymerization plant to operate with gases from the Gyro units. A gasoline recovery plant also has been installed.

●

The El Dorado Refining Company, El Dorado, Kansas, is building a new truck transport terminal at its refinery, which will be a combination transport loading rack for products in bulk and a warehouse storage for lubricating oils and greases.

●

The Security Petroleum Company's 2500-bbl. refinery at Chase, Rice County, Kansas, has been completed.

●

The Minerva Refining Company has acquired the 2200-bbl. skimming plant of the Kent Refining Company at Minerva, Texas, and operations have been resumed. The Minerva Refining Company was organized recently by E. L. Davis, S. F. Richardson and J. Smith. Headquarters are at Minerva.

●

The F. C. Henderson Gasoline Company has announced its intention of rebuilding the 150,000,000-cu. ft. daily capacity natural gasoline plant, located in the Borger, Texas, district, near Sanford, that was almost completely destroyed by fire on February 9. The plant was making approximately 1000-bbl. of gasoline production daily at the time of its destruction, the average recovery being one-third of a gallon per 1000 cu. feet.

●

A new lead-blending plant is being constructed at the Okmulgee refinery of the Empire Oil and Refining Company. When the new unit is completed it will enable the plant to produce Ethyl-treated gasoline.

●

The Baird Refining Company was organized recently by officials of the Woodley Petroleum Company to take over the Octane Refining Company's plant at Chautauqua Switch, east of Baird, Texas.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending February 24, 1934

A.P.I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	453,000	77.8	16,057	4,763
Appalachian	92.6	86,000	61.6	1,941	769
Ind., Ill., Ky.	97.3	344,000	80.9	8,382	3,621
Okla., Kans., Mo.	82.1	217,000	57.2	5,909	3,104
Inland Texas	60.2	93,000	56.3	1,335	1,655
Texas Gulf	98.1	487,000	92.3	5,421	4,871
Louisiana Gulf	100.0	113,000	69.8	1,854	1,338
No. Louisiana-Ark.	92.6	49,000	64.1	310	638
Rocky Mountain	78.8	25,000	39.3	1,070	736
California	96.9	420,000	51.1	13,697	87,417
TOTALS WEEK:					
Feb. 24, 1934	92.4	2,287,000	68.4	55,976	108,912
Feb. 17, 1934	92.4	2,224,000	66.5	55,049	110,061

Observations on Modern Meth-od and Construction of Pip

By R. W. HOWE
Vice-President and General Manager,
Atlantic Pipe Line Company

UNTIL recent years pipe lines usually were laid out rather than designed. Twenty-five years ago, most of the lines, a majority of which were situated in the Central West and in the East, were laid out for ease of construction (often following railroads) and with much emphasis on suitable station locations. Many of the stations were steam-driven, which necessitated railroad connections and good water supplies.

During the past few years, especially after the advent of the centrifugal pump, it has been necessary to give more consideration to design and better balance of stations. In the early days the average distance between stations was 40 miles and very little attention, if any, was then paid to profile or balance. If one particular station happened to be pumping up too steep a hill, and was holding back the desired capacity of the line, necessary additional capacity would be given that station by throwing in loops of pipe at any convenient place between this station and the next.

Pumping pressures 25 years ago were considerably lower than those employed today. Pipe wasn't nearly so strongly made as the modern product and frequently an 8-in. line would burst on test at a pressure of 700 pounds. If early-day pipe line stations were to carry as much as 800 lb. (common today) the line for about the first ten miles out from the station, was constructed of two 6-in. pipes, this size continuing until the pressure had fallen below 700 lb., then the line was changed to one 8-in. and occasionally further increased to a 12-in. near the next station.

BALANCING STATIONS. In laying lines to obtain balance there are two prime factors to be considered. Assuming that a line is to be laid to a new field where the grade of the crude is more or less an unknown quantity, the first thing to study is viscosity of the oil; the second is the profile of the country, and both have to be carefully determined before much can be done toward good station layout. The widespread use of centrifugal pumps has made the proper balancing of stations of increasing importance, the reason for this being that in order to get maximum efficiency from a centrifugal pump, it is necessary that this pump operate as close to its maximum head and capacity as possible. Also it is desirable to have the pumps in the different stations of the same head and if possible identical in every way.

If reciprocating pumps are to be used, the number of pump stations can often be cut down by careful study in the laying out of the stations to utilize the maximum working pressure of each station.

VISCOSITY. Viscosity is an important factor in pumping crude oil through pipe lines. Ordinarily, viscosity is expressed in terms of seconds Saybolt at 100 degrees fahrenheit. For the purpose of comparing different crudes and the viscosity characteristics when the same crude is pumped at different temperatures, one method is to run viscosities on the Saybolt viscosimeter at the temperatures likely to be encountered in pumping of oil in the region under consideration. For example, in studying East Texas crude, we would take viscosities at 100, 90, 80, 60 and 50. When viscosities thus obtained are used in connection with well-worked-out flow curves, such as the Danforth curves, very accurate calculations can be made and the behavior of the various crudes being pumped through given lengths and sizes of line can be very accurately forecast.

Fig. 1 shows such typical curves worked out for some of the crudes found in Texas.

This study of viscosity will also help in the design and selection of pumps. All crudes of reasonably low viscosity pump very well in centrifugal pumps and Gulf Coast and other crudes of as low as 25 to 27 gravity handle fairly well. Crudes as low as 20 gravity usually necessitate the use of plunger pumps. For example, Smackover Heavy (20 gravity) when it begins to get cold, becomes very viscous. It is around 285 viscosity at 100 deg. fahr. and goes above 1000 seconds Saybolt when it gets cool.

PROFILE. In connection with studying the profile for a proposed line, for carefully balanced stations, if the terminal elevation isn't too much different from the initial elevation, the problem will be one of detail in locating the stations. For example, one line 71 miles long had an initial elevation of about 2840 ft. and a final elevation of 2790 ft., a difference of 50 ft.; on driving over the right-of-way (which was really uphill) one would think one were traversing country as level as a floor. Only one station was contemplated on this line in addition to the initial station and it appeared as if the location of this station would come at approximately the middle of the line. When elevations were run, it was discovered that there were elevations as high as 400 ft. above the initial station near the middle of the line, and a station site was selected nine miles off center so that the first station pumped 27 miles and the other station 44 miles on a 71-mile line, yet the pressure at these stations balanced within less than ten pounds at the designed capacity of the line, which was 35,000 bbl. per day.

On a 500-mile line from West Texas to seaboard, the initial elevation is approximately 2800 feet. This line has 11 stations and due to differences in elevation between them, two stations pumped as far as 60 miles, one or two about 40 or 42 miles, the others averaging about 45 miles apart; these 11 stations all balanced up within a few pounds at the maximum capacity of 39,000 bbl. per day.

SIZE OF LINE. The maximum daily amount of oil to be pumped from a field in flush stages usually determines the size of a proposed line. If the run regularly approximates 40,000 or 45,000 bbl. per day, a 10-in. line would be required. With normal station locations, approximately 45 miles apart and pumping East Texas crude, for instance, through a 10-in. line under 800 lb. pressure, a throughput

ods of Design of Pipe Lines

of 43,000 bbl. per day might be expected. An 8-in. line under similar conditions, handling East Texas crude, which is of fairly low viscosity, will have a capacity of approximately 22,750 barrels and a 6-in. line, 45 miles long, 11,380 barrels. The only case in which a smaller line is at all economical is for handling flush production over a very short period, in which case booster stations would be thrown in 10 or 15 miles apart.

While discussing sizes of pipe, it might be interesting to mention the relation between different sizes, as far as the flow of oil is concerned. Naturally, we think of a 4-in. pipe in comparison with an 8-in. pipe as being proportional to the square of the diameters. In pumping long distances that is incorrect, and the capacities of the lines vary as the 4.75 power of the diameters. This is a function of the area and wetted surface of the pipe, rather than area alone. For example, one foot of 4-in. pipe has approximately the same resistance as 270 ft. of 12-in. pipe under the same pumping conditions. One foot of 4-in. pipe has the same resistance as 7.99 ft. of 6-in. pipe or 29.6 ft. of 8-in. pipe under like pumping conditions.

This difference in size of pipe is even noticeable in the different weights of the same nominal sizes of pipes. For example, on an East Texas line operating at a maximum capacity of 43,000 bbl. per day, the total pressure for this capacity is 2933 lb. per sq. inch. This particular line is laid with 10-in., 31-lb., 10¾-in. O. D. pipe. If this same line were constructed of the standard 10¾-in. O. D., 41-lb. pipe, it would require 290 lb. more pressure to put the same amount of oil per day through this line.

The gravity of oil does not affect design very much, but may affect the power required and slightly affects the pressure put up by a centrifugal pump under constant conditions of speed and design.

STATION PRESSURES. Lines laid to flush fields usually experience a decrease in available oil after a few years and the question might well be asked, should the stations be balanced for maximum flush capacity or for the average over, say, ten years? I believe the answer is to balance for flush production, for the reason that the power characteristics of the average pipe line show that the maximum capacity of a line calls for huge power consumption and, when running at maximum, every possible point of efficiency is important, and the matter of power will to a certain extent, take care of itself as the capacity of the line goes down.

It will pay, therefore, in laying out stations to select pumps and lay out stations for the highest reasonable capacity of the line. This will give the best efficiency and maximum economical operating conditions throughout the life of the line. For example, a certain pipe line serving the East Texas field started off with a low capacity, but expected a gradually increasing demand for additional capacity in this line. At the start this line was 10-in. and 187 miles long with one pump station, and with one unit running in this station and consuming about 212 hp. the capacity was 15,000 bbl. per 24 hours. An additional pump in the initial station, which was the only one built at the start, increased this capacity to 22,000 bbl. per day and about 490 total horsepower. One intermediate station with two units boosted the capacity to 31,000 bbl. per day and the horsepower to 1160, or nearly six times the horsepower that was used for 15,000 barrels per day. Later, when the line was put up to a full capacity of 43,000 bbl. per day, approximately 2750 hp. was used. Thus it will be seen that the ultimate capacity of the line should be kept firmly in mind from the start so that if and when it is necessary to use the line at its fullest economical capacity, the station layout and pump design will be such as to give the best possible balance and maximum pump efficiency, as it is at this time that the horsepower used is highest.

Another good example is a 71-mile line (shown in profile) using 1000 hp. and pumping 35,000 bbl. per day, which was increased to 53,000 barrels. The horsepower was tripled for a 50 per cent increase in capacity obtained. This gives some idea of the economic maximum of pipe lines. It was economical to spend all that money for increased horsepower for a period of only 18 months because of peculiar conditions in the field. It can readily be seen that if the line declines appreciably, power costs will be very much lower and power cost per barrel will be fairly constant.

CONSTRUCTION STANDARDIZED. Construction of pipe lines has become more or less standardized during the last few years. Welding has been perfected since its use first became prevalent. At that time only acetylene welding was commonly used, requiring a butt-welded joint. In those days we treated the line rough, testing it by deliberately trying to break out the occasional bad welds. Nowadays, with modern acetylene or electric processes and experienced organizations, welding is universally good. In fact, some recent lines have been constructed and practically no testing done until the line was completed and in the ditch, when a preliminary cold water test was made.

Another important thing in the construction of a pipe line is to allow plenty of slack for expansion and contraction. In fact, we consider that factor the prime requisite of a good pipe line job. Our usual method (particularly when the line is laid in the summer) is to lower the pipe early in the morning (between 4 o'clock and daylight). Every sixth or seventh joint is crotched up to the top of the ditch and the ditch filled between these loops where the pipe rests on the bottom. The next morning crotches are removed, the pipe forced into the ditch and the covering completed. If some such plan is followed so that an even and constant amount of slack is put in the line (and the inspectors insist that the maximum rather than the minimum amount of possible slack be put in), very little trouble will be encountered, for by carrying out this plan the joints will not be in tension and the line will not pull apart during the first cold weather.

Normal Texas temperatures call for about three ft. of slack to the mile, and while this seems to be a very small percentage, it is almost unbelievable how much crowding must be done to get that amount of extra pipe "in the ditch." The writer has witnessed instances where, when lowering down-hill from both sides into a valley, a loop of slack as high as a man can reach would accumulate. One would estimate that at least a foot of pipe would have to be cut out to make this line lie flat in the ditch. As a matter of fact it was only necessary to cut out the width of a weld (about an inch) and the pipe readily dropped into the ditch.

CONSTRUCTION. The principal factors in every pipe line construction job are transportation and timing. The success of your organization depends almost entirely upon perfect timing. With an ordinary pipe line gang, costing, say $1,500 per day, if the pipe supply, welding material or other essentials are allowed to run out the resultant loss is enormous. On a quick job a great deal of money can be lost by carelessness. On the other hand, with careful attention to details of organization and supply, remarkable speed

can be made in pipe line construction. A striking example of this was a line from McCamey, Texas, to the Corpus Christi area in Texas. The average haul from the railroad was about 50 miles. The ditch was practically all hard rock, something like 300 carloads of dynamite being required and thousands of feet of drill steel used. In spite of this, the line was completed and pumping oil within five or six months.

RIGHT-OF-WAY. At one time right-of-ways were selected to follow the line of least resistance, and usually were close to railroads and away from mountainous country. Nowadays lines are laid as nearly straight as possible and usually the only departure from a straight line is to attain suitable points for river crossings or to avoid large towns. Of course, there may be minor exceptions to avoid sharp gulleys and steep cliffs, but usually, for sake of economy, departure from the straight line principle is allowable only to avoid major construction difficulties.

The depth of ditch should be mentioned. It is, of course, necessary that the line be buried deep enough to escape all, except seasonal, variations of temperature. Usually 18 in. is ample for this, although Texas regulations require a 20-in. fill on top of pipe laid through plowed ground.

In this connection, it is interesting to note the effect of the temperature of the ground on the temperature of the oil pumped. For example, in West Texas oil cools quicker than along the Gulf Coast and, at certain seasons of the year, arrives at the coast ten degrees warmer than when it started. Oil that is usually warm will drop to the temperature of the ground for that vicinity when it has been pumped anywhere from 15 to 30 miles, and thereafter throughout the length of the line will take the normal temperature of the ground in whatever region of the country.

PIPE PROTECTION. The problem of protection of pipe lines against corrosion is one that has been studied extensively; although great progress has been made, there is much yet to be learned and the subject is too big to be discussed fully in this article. There are many methods of protection and many materials on the market for this purpose. It is generally conceded that some material impervious to water and not affected by the soil should cover the pipe and a wrapping used to prevent the soil stress from distorting or destroying this covering. Experience is showing gradually that certain materials are effective under certain conditions of soil moisture, etc., and the success of the protection depends upon careful selection of a material suitable for the soil through which each particular part of the line passes. Some companies protect their lines throughout, while others employ protective measures only in the "hot spots."

Recently the effect of electric currents on pipe lines and the relation between the polarity of the pipe and soil have been studied and considerable success attained in stopping electrolytic corrosion by preventing the flow of current through the pipe by the addition of an outside source of electricity.

STATION DESIGN AND CONSTRUCTION. Originally all stations were equipped with steam pumps, many being of the direct-acting plunger type, but the Corliss valve fly-wheel type was used on some lines and fairly good fuel economy obtained. Internal combustion engines driving power pumps first appeared about 1907 and, from 1910 to 1925, virtually all installations consisted of Diesel engines driving reciprocating pumps. At first these Diesel units were very small, the average size being probably 100 horsepower. The principal change during this period was the rapidly increasing size of the units, for which there were two reasons, one being the improvement of the Diesel engine itself and the other the greatly increased capacity of the average trunk line.

During the period, 1927-1928, the trend shifted to electric-driven centrifugal pumps, particularly in West Texas and similar areas where water was of bad quality and scarce. Among the reasons for this shifting was the fact that large capacity Diesel reciprocating pumps required extensive foundations and large buildings, making original station cost high compared with the cost of the equivalent size electric-driven centrifugal station. Also the latter can be constructed very quickly and the operation and upkeep are minor considerations. The question of whether to install electric-driven centrifugal pumps or Diesel-driven pumps is principally one of economics, depending upon the probable length of time the station is expected to run at full capacity, availability of power, etc.

Another type of installation has appeared in the last three or four years: the Diesel engine driving centrifugal pumps through increasing gears. This type was developed with the idea of combining the economy of the Diesel with the lower cost of pump, foundation, etc., of the centrifugal and to get the advantage of flexibility of the latter. This type of

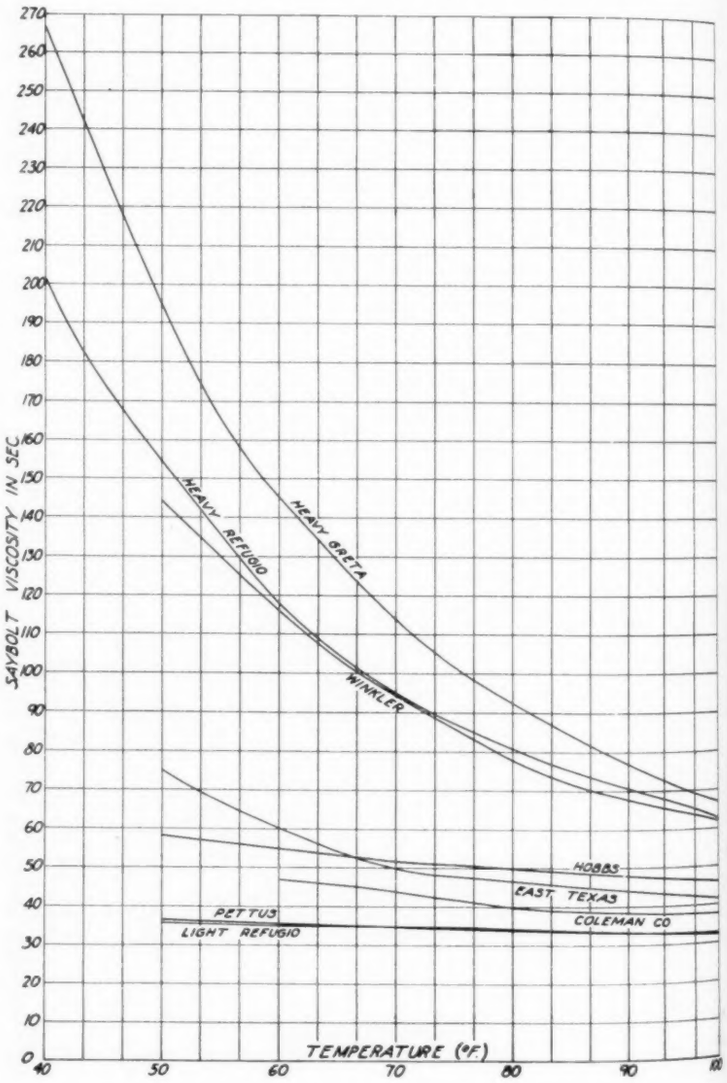


Fig. 1. Viscosity Curves for Texas Crudes

installation is adapted particularly to booster stations where power is not available, or where the probable life of the station does not warrant the construction of a long power line. It has become quite popular in the last few years. Some stations have been constructed using the Diesel electric drive instead of the Diesel increasing gear drive, the latter type further increasing the flexibility of the installation.

One development that has increased the popularity of this latter type is a radical improvement in the design of cooling system for the Diesel engines. In previous years the water supply was an all-important consideration in the use of both steam and Diesel engines and many elaborate water systems were constructed to serve the large installations. Almost all present installations use an exchanger and cool the jacket water with the oil being pumped by the station. This method has two distinct advantages, first, it is compact and easily and economically installed, and, secondly, the amount of water contained in the system is extremely small, the concentration negligible, the water can be treated easily and scale and corrosion eliminated.

OPERATION OF LINE. The operation of the average pipe line is carried on very much the same as that of a railroad. It is necessary to maintain reliable and constant telephone service throughout the length of the system and almost all pipe line companies run telephone lines alongside their pipe lines.

The dispatcher ascertains the exact number of barrels pumped by the initial station, takes this original amount of oil and adds to it plus or minus the gain or decrease in any station tank that may be on the line. He then determines the amount of oil received at the terminal and checks this against the original figure. This is usually done hourly. Overs and shorts will occur from hour to hour, but the overall check will be remarkably close. However, if the dispatcher starts running short consistently he will immediately start an investigation, recheck all gauges, etc., and if he cannot find reason for the continued shortage probably will shut down and cover the line. Of course, any large break will immediately show up in the pressure, regardless of the hourly check, but a good dispatcher can find even small leaks with the combination of pressure and hourly checks.

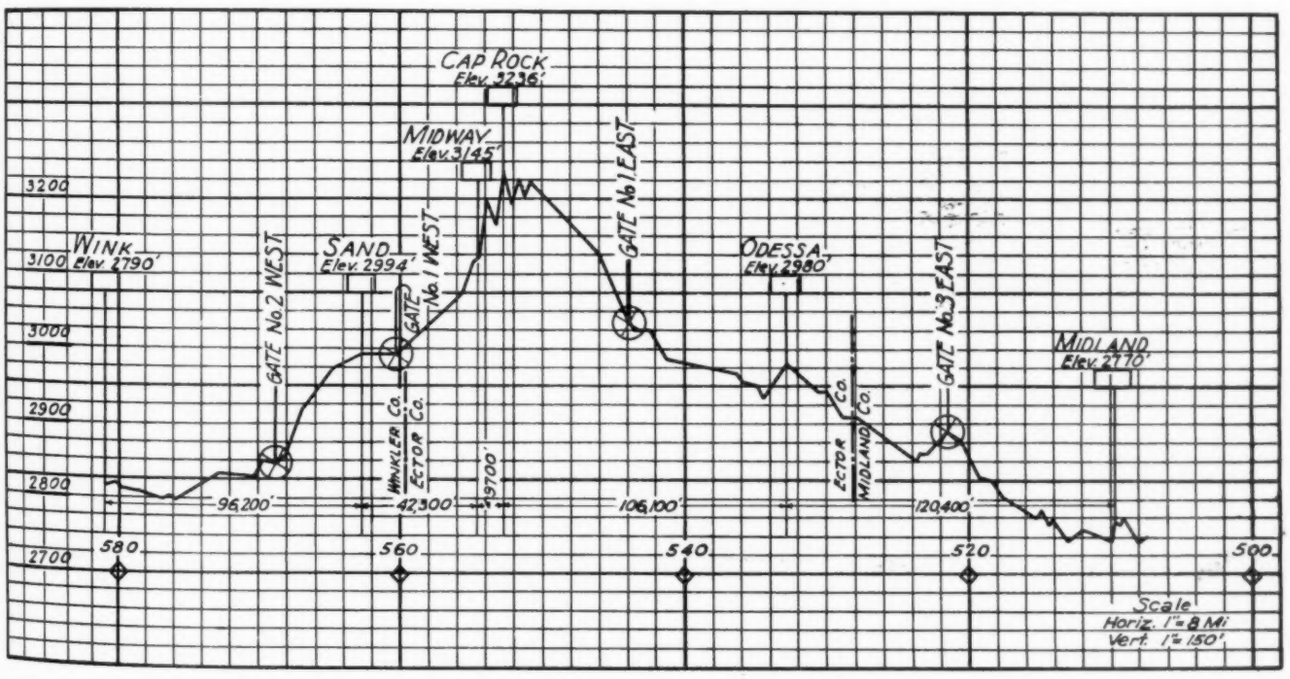
When a line is running at full capacity, each station probably will have a tank on the line. Originally many stations had large tanks of, say, 35,000- or 55,000-bbl. capacity and pumped in and out of these station tanks. This, however, caused large evaporation losses, particularly in the case of lighter crudes; many lines now use only a small tank, say, 10,000-bbl. capacity, at each station, and float it on the line, i.e., the tank is opened on the suction side of the pump and receives or delivers only the difference in the amount of oil pumped by the station as compared with that received from the station behind.

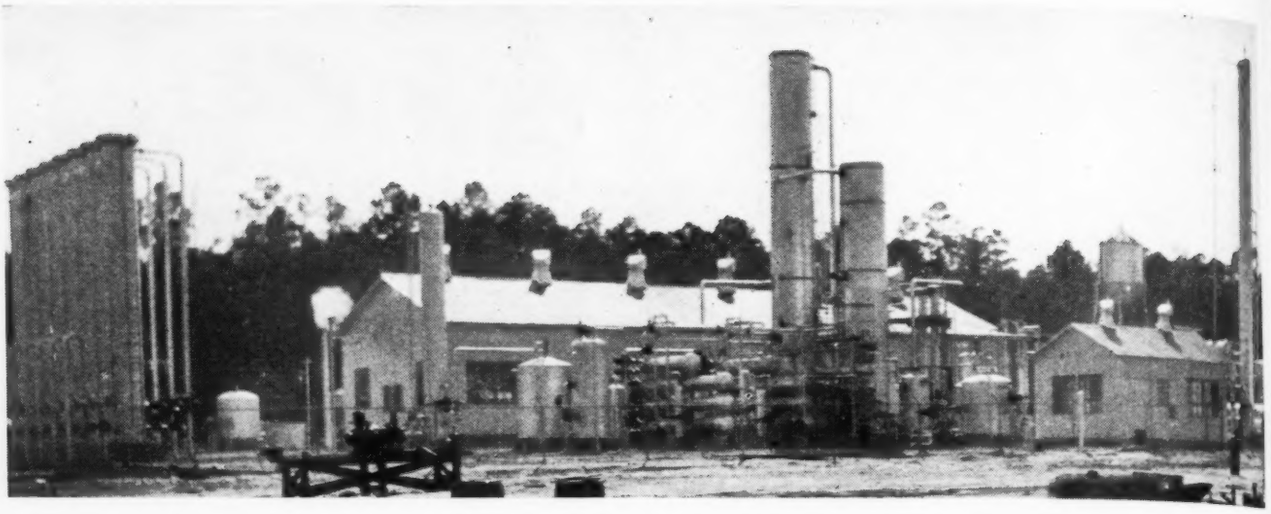
With centrifugal pumps it is possible to put a relief valve between the suction of the pump and the tank and, if the line is properly balanced, pump straight through without any oil at all going into the tank. If for any reason the station, or a portion of it, should be shut down, the excess oil from the previous station will pass through the relief valve into the tank and prevent undue pressure on the line. There are distinct advantages to be derived from the latter type of operation and evaporation losses can be reduced sharply by it. Whenever pipe line oil is put into or removed from a tank, there is almost always an evaporation loss, regardless of the type of tank used.

INSPECTION. The reliability of materials and modern construction methods have reduced the required amount of daily inspection. In the days of the old screwed line the linewalker was a prominent member of the pipe line personnel. Expansion and contraction of the line as the seasons changed caused a certain amount of leakage, and it was necessary to keep it inspected constantly to find these small leaks and caulk them, preventing loss of oil and damage to property.

On most of the newer welded lines this daily line walking is dispensed with and comprehensive and careful inspections made periodically. The chief source of trouble on the modern line is leaks due to corrosion and most companies attempt to make their inspections carefully enough so as to find such points as are likely to produce corrosion, reconditioning them before leakage actually occurs.

Fig. 2. Profile 10-in. Line, Wink to Midland





Exterior view of the Myrtis Gasoline Plant

United's Myrtis Gasoline Plant E

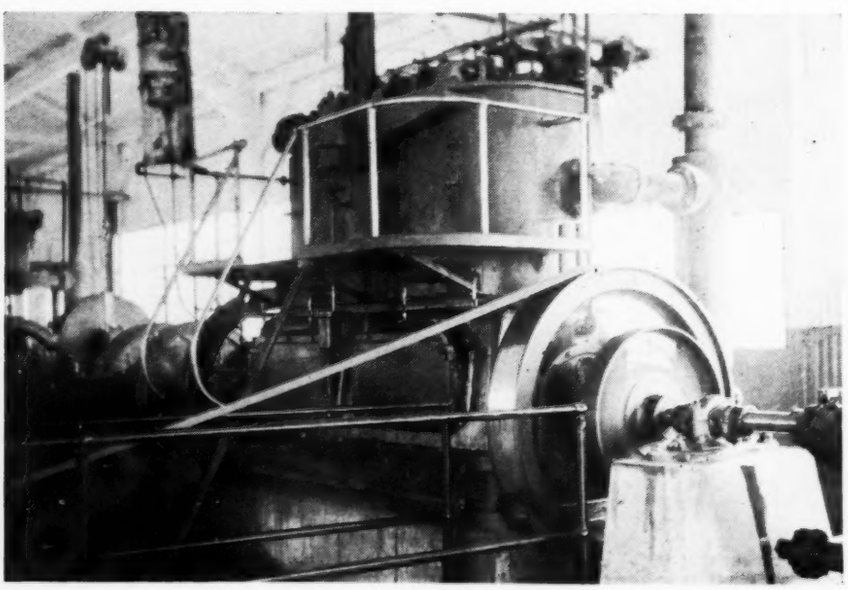
30,000,000 Cu. Ft. High-Pressure Plant Operates On Rodessa Field Gas

A HIGH-PRESSURE absorption plant recently constructed at Myrtis, Louisiana, by the United Gas Public Service Company, subsidiary of the United Gas System, embodies a number of unusual features, among them being a ratio flow control on absorbers; the use of two stills, one to handle mineral seal oil, the other for processing drip gasoline; and a compressor unit for collecting wild vapors from the stabilizer and high-pressure vent tank and putting them back into the main outlet line.

Full advantage is taken of the efficiency and economy of automatic control devices. Not only are the back pressure on the stills and the main line gas leaving the absorbers regulated automatically, but the operating pressure on the plant is thus controlled, as are the temperature of stills and stabilizer, the flow of the feed and reflux to the stabilizer and the ratio flow of mineral seal oil to gas.

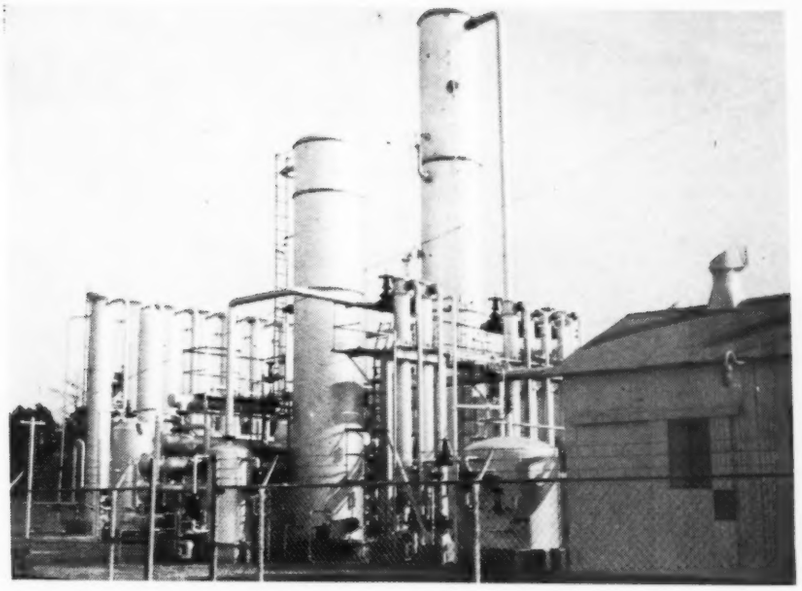
The ratio flow control on the absorbers has for its function the maintaining of proper ratio of lean oil to gas. The instrument is constructed with two sets of differential pressure chambers, one set being connected to an orifice in the primary line (or the one handling the gas) and the other to an orifice in the secondary line (or that handling lean oil). The chambers may be either of equal or dissimilar differential range, depending upon the difference in the two flows. The orifices are computed for the desired flow ratio and minor changes made with the ratio adjustment built into the instrument.

This control, in reality, is comprised of two instruments so connected that the differential pressure created by the flow of the primary fluid operates the setting device of the control mechanism in the secondary or controlling instrument in such a way as to maintain their differentials equal if the two ranges are equal. If the two ranges are unequal the differentials are maintained in proportion to the scale lengths. With such an arrangement, although the rate of the gas may vary considerably, the flow rate of the mineral seal oil will always be in direct ratio to the flow of the gas. A double-action shock-absorber protects the fixed ratio relation at all times against damage from over-range. Should an over-range of either differential occur, the instrument is protected, although temporarily the flow ratio will not be maintained.



165-hp. Bruce McBeth engine driving an oil pump, two centrifugal water pumps and a two-stage compressor

View showing the stills



By FRANK H. LOVE

Embodies Many New Features

Two stills are used in the Myrtis plant, a practice common in localities where casinghead gas is processed, but somewhat unusual in plants handling only natural gas. The stills are of the bubble-tray type, and automatic controls regulate the back-pressure and temperature. The main still, operating on a 40-lb. pressure, treats the vapors coming from the absorbers, while the other still, with approximately 12-lb. pressure, handles drip from the scrubbers. The finished product of the two stills is blended in the stock tanks.

Gasoline content varies from 600 gal. per million cu. ft. for drip down to 400 gal. per million cu. ft. for that processed from vapors coming off the absorbers.

The engineering department of the United Gas Public Service Company has worked out a method for handling wild vapors that is as interesting as it is unique. One of the power cylinders was removed from a 110-hp. twin-cylinder gas engine and in its place was installed a compressor cylinder. This unit, shown in one of the accompanying illustrations, collects the wild vapors from the stabilizer and high-pressure vent tank and puts them back into the main outlet line handling dry gas for commercial consumption. Since its installation the converted gas engine-compressor has worked most satisfactorily.

Vapors off the low-pressure vent tank are run through a reabsorber and the excess is used as fuel for the boilers.

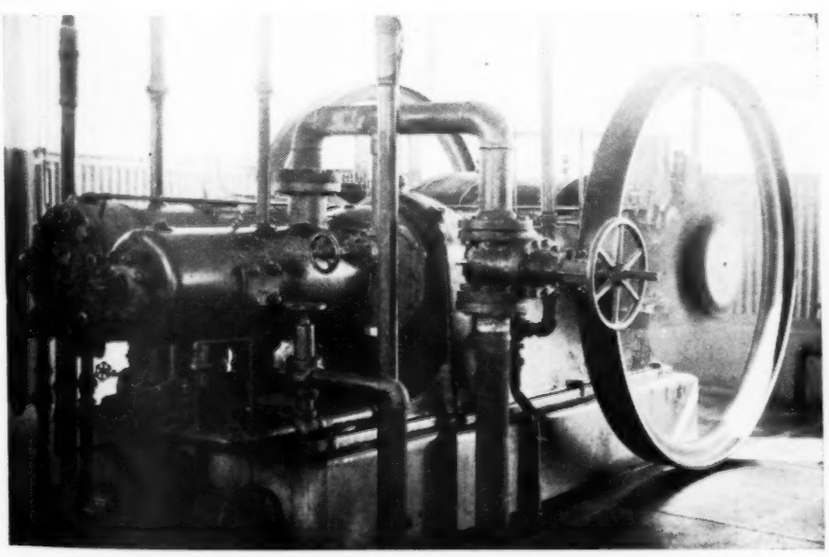
On the main outlet gas line a scrubber with a tracyfier baffle is used to prevent any mineral seal oil, drip or other moisture, from finding an outlet.

Designed by and constructed under the supervision of United's own engineers, the plant originally was completed with a capacity of 15,000,000 cu. ft. daily, but December last additional units were installed, increasing the capacity to 30,000,000 cu. feet. The present average daily volume of gas consumption is approximately 20,000,000 cu. feet.

The plant operates on 400-lb. average pressure and is equipped to produce any grade of natural gasoline. Just now 18-lb. vapor tension gasoline is being manufactured.

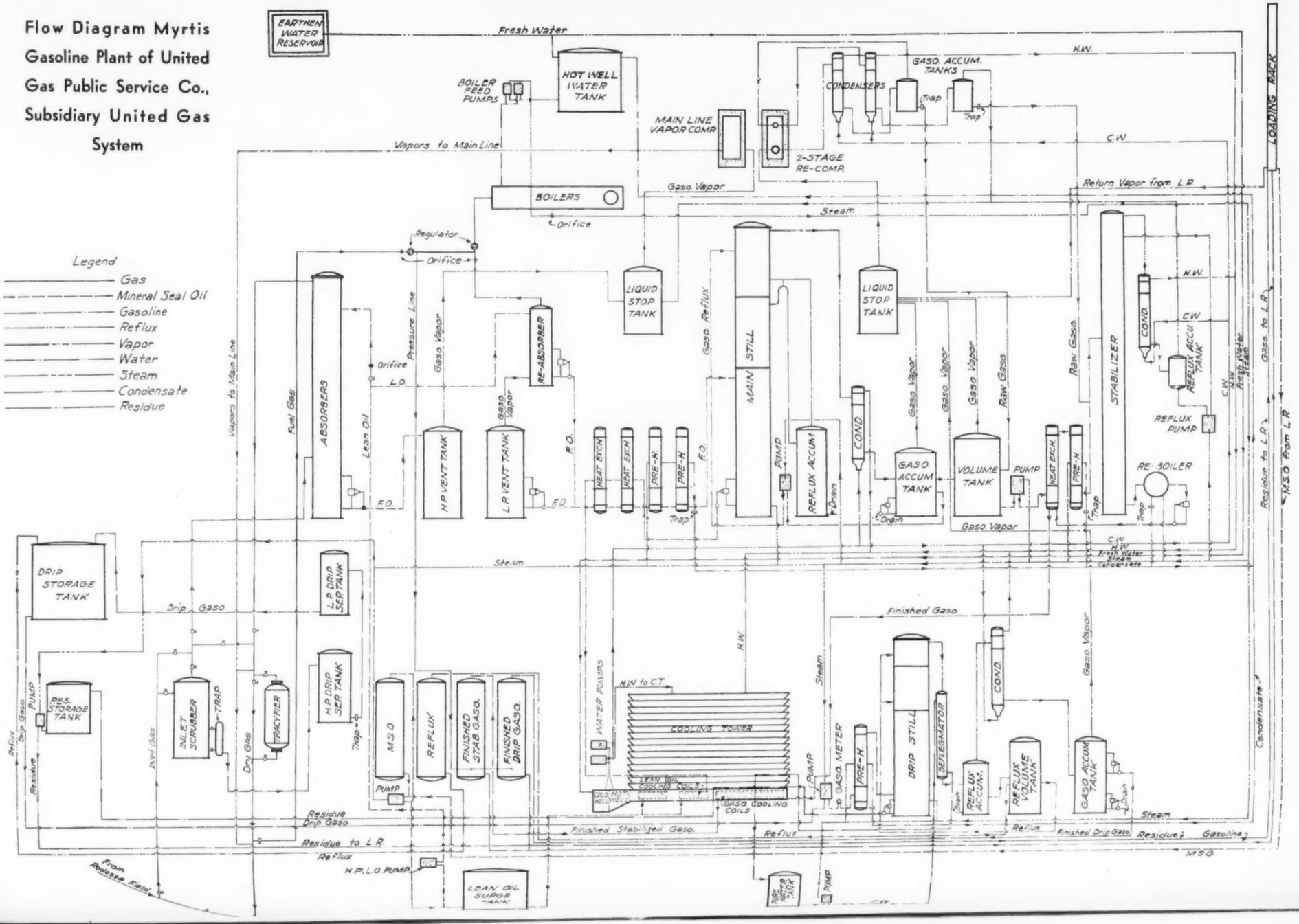
A perusal of the flow sheet of the Myrtis plant shows the natural gas entering the scrubbers from the wells through a 10-in. main gathering line. There the water, sludge and drip are eliminated, the gas passing on to the absorbers (eight in number), entering at the bottom through a regulation orifice plate and passing upward to an outlet at the top. The ratio of mineral seal oil to gas entering the absorbers is regulated by the ratio flow control instrument previously mentioned. Dry gas coming off the absorbers vents into the main outlet line to be used for domestic and industrial purposes. Pressure on this line varies according to the load, but usually ranges from 350 to 400 pounds.

The mineral seal oil with entrained gas



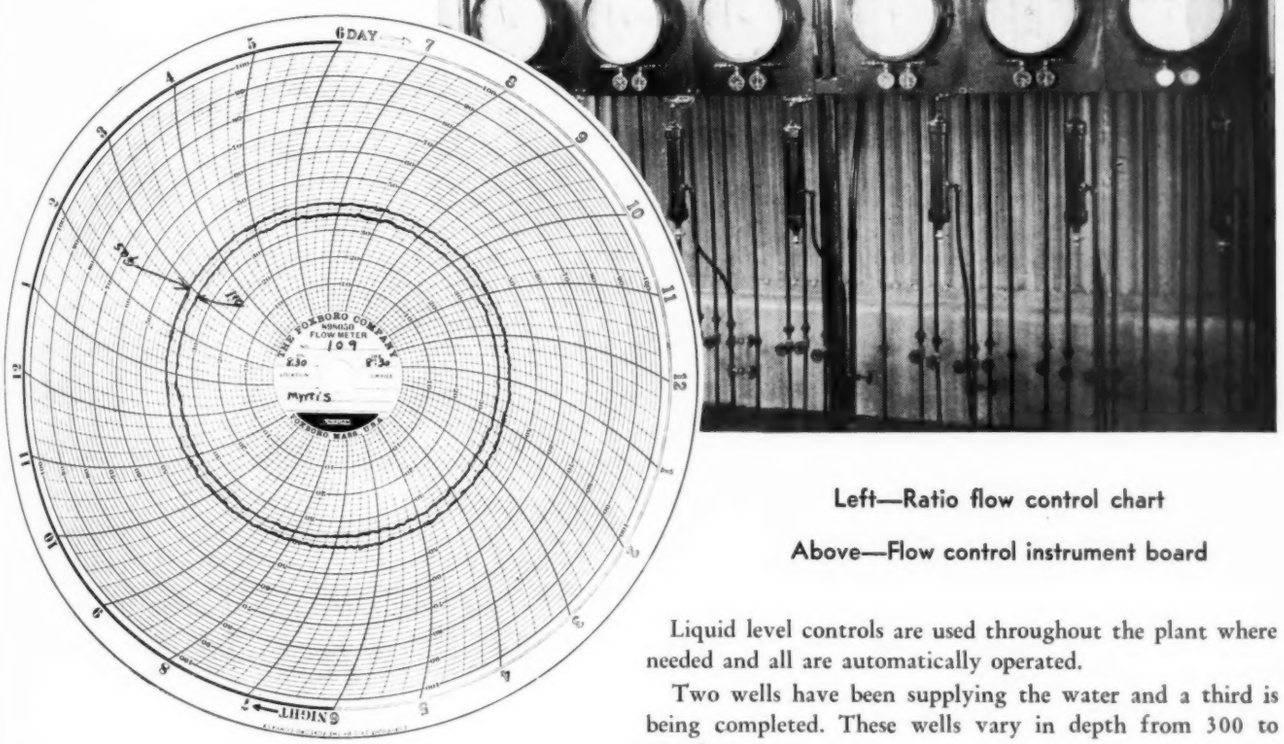
Cooper-Bessemer 110-hp. engine, one cylinder of which has been replaced by a compressor

Flow Diagram Myrtis Gasoline Plant of United Gas Public Service Co., Subsidiary United Gas System



passes through the high-pressure vent tank (on which is maintained an average pressure of 150 lb.) to the low-pressure vent tank (with a 75-lb. average pressure) and thence to the heat exchanger, the pre-heater and still. From the latter the gasoline vapors are conducted to the condensers and the gasoline collected in the accumulating tank. The mineral seal oil is discharged at the bottom of the still and runs through the heat exchanger countercurrent to the cold, or rich, oil. The lean oil passes through the coolers before being charged to a high-pressure pump, operating on a pressure 50 to 150 lb. greater than the gas pressure, and recirculated to the absorbers, completing the first cycle.

Raw gasoline from the stills, being of high vapor tension, is processed through the high-pressure stabilizer where desired specifications are obtained. The stabilizer temperature is automatically regulated, as are flow controls on feed and reflux to the stabilizer.



Left—Ratio flow control chart

Above—Flow control instrument board

When the gasoline leaves the stabilizer it is run to stock tanks and loaded from there under pressure. A modern rack has been constructed to handle the loading. Vapors arising from the tank cars are returned to the plant for recompression by means of a patented loading head.

The compressor room houses three compressors, two oil pumps and four circulating water pumps. Prime-movers consist of two 165-hp. gas engines, both of which are put into service when the plant is carrying a full load, one being used as a stand-by when operations are at light capacity. Direct-connected to each, by means of flexible couplings, is a 5x10 triplex high-pressure oil pump that circulates the mineral seal oil to the absorbers. On the opposite side, also direct-connected by flexible couplings, is a tandem two-stage compressor, 10x4¾x12, to handle vapors from the stills. Operated by a belt off the flywheel of the gas engine are two centrifugal water pumps, one for circulating water through the condensers and the second for forcing water from the pit to the top of the cooling tower. The third compressor is the converted unit used for collecting wild vapors.

Six 65-hp. and one 72-hp. oilfield boilers generate steam required by the stills and for operation of the pumps.

The finished gasoline is stored in nine 10,000-gal. and four 8,000-gal. horizontal tanks, giving a storage capacity of 122,000 gallons.

Two surge tanks are employed, one of 5,000-gal. capacity for lean oil, situated between the cooling tower and high-pressure pumps; the other, a volume tank for raw gasoline before it is pumped to the stabilizer, is of 10,000-gal. capacity.

Liquid level controls are used throughout the plant where needed and all are automatically operated.

Two wells have been supplying the water and a third is being completed. These wells vary in depth from 300 to 350 feet.

All pipe work is buried, except for the steam lines, which are overhead. Buildings are of sheet metal, with concrete foundations for all machinery. No electric generating plant was installed, power being taken from the highline of the Southwestern Gas and Electric Company, two miles of line having been strung to make the proper hook-up.

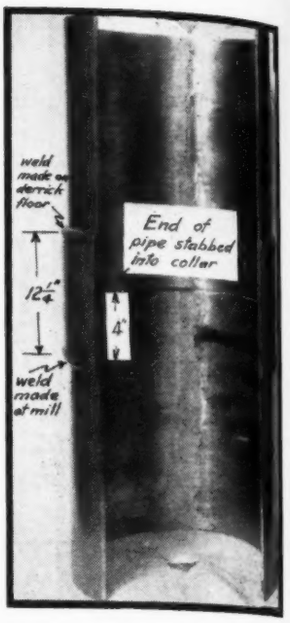
The source of gas supply is the near-by Rodessa field, discovered four years ago and developed considerably during the last year. Gas from this field is sweet and needs no chemical treatment.

The main gathering line, two miles in length, is constructed of 10-in. pipe, while the laterals are of 4-in. and 6-in. pipe.

J. L. Gilbert is the superintendent in charge of operations at the Myrtis plant. F. E. Rhodes is Louisiana superintendent of operations for the United Gas Public Service Company, making his headquarters at Shreveport.

New Record with 16-Inch Welded Casing

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles



Work of welding and running in casing is speeded up by the self-aligning joint formed by having a collar pre-welded to one end of each length of pipe.

OF far greater importance than the mere establishment of a record was the running of a 5087-ft. string of 16-in. surface casing by the Associated Oil Company in its well V. L. & W. No. 27 at Ventura, California. The landing and cementing of this casing shows the availability of big diameter holes at nearly a mile below ground; and the speed with which the operation was performed proves how rapidly surface casing can be welded and run to great depths. Deeper wells than any now drilled can be expected within the next few years, so every method that may offer a means of facilitating drilling progress is worthy of attention.

Quite a number of surface strings have been welded in California during the past year and the practice has naturally been improved with regard to both method and speed. Comparisons with screwed surfacing casing will not here be given, since the running of this kind of pipe is well known; and due consideration of the advantages of both the welded and screwed casing will be influenced by the conditions encountered.

The record string of pipe run in V. L. & W. well No. 27 consisted of 128 joints (40-ft.) of A. O. Smith special, 16-in. 77.75-lb. surface casing. Its specifications are 16-in. O. D.; 15.125-in. I. D.; wall thickness 0.4375-in.; and test pressure 1650 lb. per sq. inch. The collars used were 16.875-in. O. D. and one was welded to one end of each joint before delivery at the well. These collars formed a self-aligning joint that eliminated any necessity for tacking and required only one circumferential weld at each joint. This is shown in the accompanying illustration.

The casing was furnished and electric-welded by U. C. Murcell, Inc., of Los Angeles. Three generators, with a rating of 800 amp. each, furnished the current. Covered rods were used for making the welds, the covering acting as a flux and forming a slag that was peened off after each pass. The slag, in being formed, liberates a carbon oxide that takes on oxygen from the air; its deposit is similar in appearance to burned sugar, is hard and brittle, and is readily peened off.

Of the 128 joints making up the string, 100 were made with three passes and the other 28 with four passes, the latter being the last made and the ones in the upper section of the pipe. The electric-welding was done in accordance with the practice developed by laboratory test work. As mentioned above and as shown in the drawing, no buttons or holes were used and the two welds, one made at the mill and one on the derrick floor, connected the joints by means of the collar. Thorough peening was done after each pass.

Two crews were used on the job and each consisted of three welders and one man for peening. Necessary precautions had to be taken to protect the eyes of the drillers who had to stay on the job and of the other men working on the floor. Two screens were used for this purpose. To shield the driller's position a fixed screen was placed so that the driller could be shielded and yet look around it when necessary without removing his hands from the controls. A swinging screen was placed in front of the walk. When a joint of pipe had to be pulled into the derrick, the screen was swung back out of the way. The men working above wore dark glasses.

A National automatic spider and slips were used in the table. To facilitate the raising of the joints from the walk, a sling, made of an iron stirrup coincident in arc with the half circumference of the pipe and with rings at each end through which ran a 1-in. manila rope, was used to carry the pipe to its position above the table. This was easily removed to give place to the elevator after the joint was placed in the collar of the joint already in the hole. Since the collar provided a self-aligning joint, the welding of the joint was done while the sling was being removed and the elevator latched below the collar of the top joint.

In contemplating the use of welded surface casing, consideration must naturally be taken of the speed with which the joints can be welded. In the V. L. & W. well No. 27, the 5087 ft. of 16-in. casing were run with a total elapsed time of 16 hours and 9 minutes, or 7.57 minutes per joint. The elapsed time was measured from the time the shoe joint was picked up until the last joint was landed and the elevators removed. It included, of course, all lost time.

The average welding cycle for all welds was seven minutes. This cycle was made up of: picking up the joint with the rope; hoisting with rope; setting joint down plumb; setting elevator at top (welding being done simultaneously with this operation); welding the joint; hoisting and releasing slips; landing newly welded joint; setting slips; and releasing elevator.

Including the peening after each pass, the average time consumed in making the welds with three passes was 4.7 minutes and that in making welds with four passes was just over 7 minutes. The average for all welds was 5.2 minutes.

The string was equipped with a Baker whirler shoe and at the top of the first 40-ft. joint with a Baker float collar. Normal floating-in practice was followed although fluid was circulated for from 6 to 14 minutes periodically after the first 37 joints were run in. A stabbing board was erected about 40 ft. above the derrick floor and a hose carried to it for convenience in putting mud fluid into the casing while the welding was being done.

The string was cemented by the Perkins method with two outfits on the job, and the 1000 sacks of cement used were mixed in 32 minutes and displaced in 55 minutes. It took 6230.5 cu. ft. of mud for displacement and the theoretical height to which the cement rose behind the casing was 1286 feet. In accordance with some experimental work now being conducted, 26 sacks of Aquagel were added to the water used for mixing the cement.

"Roots" Type Blowers for Pumping Inert Gas

Article II

By NEIL B. MUSSER
Sc. M. (M.I.T.)

INSTRUCTIONS FOR COMPUTING CAPACITY OF ROOTS TYPE BLOWERS. Referring to Fig. 2, we see that blower B is a 11.33x20.5-in. machine, with a displacement of three cu. ft. per revolution. Let us compute the capacity of this machine at six lb. per sq. in. pressure differential, or the service load. It will first be necessary to run a slip test on the blower, which can best be done in the builder's shop, where there are facilities for driving at variable speeds, down to 50 or 100 r.p.m. The slip test consists of blanking the discharge, and measuring the pressure built up therein while driving the blower at various speeds with suction open to the air. A curve can then be plotted, as given in Fig. 2, from which the slip at any pressure differential can be determined. It is assumed that in practice, with suction temperatures and pressures not far from those obtaining on slip test, that there will be the same number of r.p.m. lost at any pressure differential that would be turned over on the slip test. In other words, for a differential of six lb. per sq. in. for blower B, 122 r.p.m. or 366 cu. ft. of air referred to suction conditions would be lost, or by-passed back through the blower, regardless of how fast the blower might be turning over at the time the six-lb. differential exists.

Data required:

Suction pressure, 14.45 lb. sq. inch.
Pressure differential, 6 lb. sq. inch.
Suction (room) temp., 39 deg. fahr. (Assumed same as for slip test, Fig. 2) = 499 deg. absolute.
Blower speed, 580 r.p.m.
Slip speed 122 r.p.m.

Net speed 458 r.p.m.
Capacity, based on suction = $458 \times 3 = 1374$ cu. ft./min.
Free air (60 deg. fahr., atmos.) capacity =

$$1374 \times \frac{520}{499} \times \frac{14.45}{14.7} = 1410 \text{ cu. ft./min.}$$

Lb. air pumped per hour = $.0764 \times 1410 \times 60 =$ 6480 lb./hr.

EFFICIENCY OF ROOTS BLOWERS. By varying the clearances between the rather wide limits indicated by Fig. 1, considerable variation in slip can be obtained, as indicated in Fig. 2. For handling clean air drawn through some sort of felt filter or expanded metal and oil filter, much less clearance can be used than for pumping flue gas. Of course, a large part of the difference shown in Fig. 2 between

TABLE I—Capacity, Power, Slip and Efficiency Tests of Random "Roots" Type Blowers

BLOWER SIZE, INCHES	BLOWER SYMBOL (FIG. 2)	BLOWER RPM TEST (R)	SUCTION PRESS. (p_s) #/sq.in. ABSOLUTE	DISCHARGE PRESS (p_d) #/sq. in. ABSOLUTE	PRESSURE DIFFERENTIAL #/sq.in	SLIP R.P.M. (FIG. 2) (r_s)	NET RPM (R-r_s)	DISPLACEMENT PER REVOLUTION (FIG. 2)	TEMP. SUCTION °F. ABS.	NET CAPACITY OF BLOWER CU. FT./MIN - BASED ON:- SUCTION CONDITIONS	NET CAPACITY OF BLOWER CU. FT./MIN - BASED ON:- FREE AIR 60°F.-ATMOS.	USEFUL HP. ADIABATIC COMPRESSION (a)	MOTOR B.H.P. BASED ON ELEC. INPUT & MFR'S EFFICIENCY TEST.	% OVERALL BLOWER EFFICIENCY INCL. BELT LOSS (NO SLIPPAGE)
11.33 x 20.5	B	577	14.7	19.6	4.9	110	467	3	540	1401	1350	27.1	38.7	70
6x18 (2 BLOWERS TESTED)	E	352	14.4	14.8	0.4	(c) 80	272	3/4	540	204	197	0.34	0.66	52
		558	14.3	14.9	0.6	(c) 98	460		"	345	332	0.83	1.68	49
		774	14.2	15.0	0.8	(c) 114	660		"	495	477	1.66	2.91	57
		986	14.0	15.0	1.0	132	854		"	640	616	2.72	5.00	54
		1223	14.0	15.3	1.3	147	1076		"	808	778	4.39	7.61	58
		1171	14.2	16.0	1.8	172	999		"	749	722	5.56	9.08	61
		1045	13.8	15.7	1.9	178	867		560	651	605	5.19	9.33	56
		1022	14.0	16.5	2.5	208	814		"	610	567	6.48	10.48	62
		1192	13.6	15.9	2.3	200	992		"	745	692	7.29	11.92	61
		1043	14.6	18.0	3.4	236	807		540	605	583	8.26	13.94	59
		979	14.3	17.8	3.5	239	740		560	555	516	7.81	13.79	57
6x18	E,	605	14.7	17.4	2.7	(b) 254	351	3/4	543	263	252	2.89	6.55	44
5x15	D	700	14.7	17.5	2.8	(b) 255	445	5/11	543	202	193	2.29	4.26	54
		707	14.7	16.0	1.3	178	529		"	240	230	1.26	3.22	39

NOTES: (a) Hp. output of blower, assuming adiabatic compression $= 1.51\ C p_s \left\{ \left(\frac{p_d}{p_s} \right)^{\frac{1}{3.45}} - 1 \right\}$ (See Kent, 9th Ed., p. 634).

where: $C = \frac{\text{cu. ft./min.}}{100}$ } Based on suction conditions.

(b) This slip taken from actual test—not from average curve, Fig. 2.

(c) Estimated, Fig. 2.

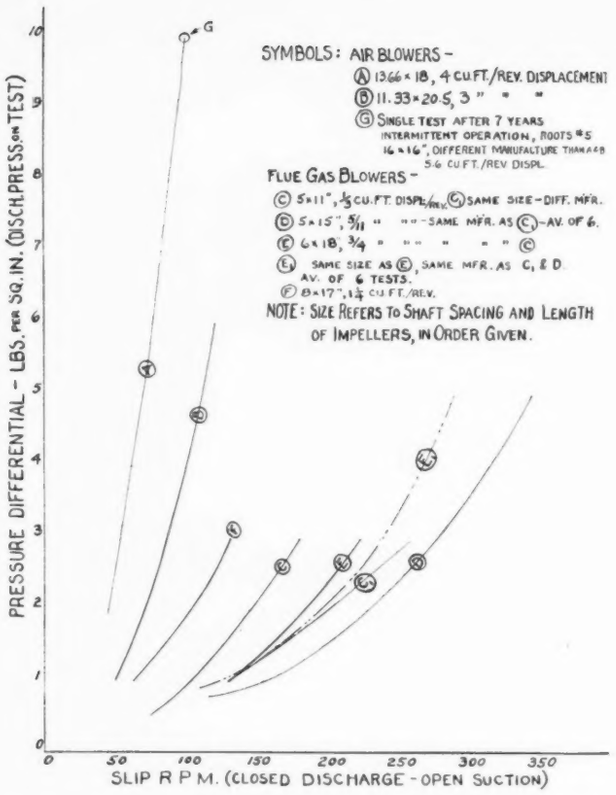

PRESSURE DIFFERENTIAL - LBS. PER SQ. IN. (DISCH. PRESS. on TEST)
SLIP R P M. (CLOSED DISCHARGE - OPEN SUCTION)
SYMBOLS: AIR BLOWERS -
Ⓐ 13.66 × 18, 4 CU. FT./REV. DISPLACEMENT
Ⓑ 11.33 × 20.5, 3 " " "
Ⓖ SINGLE TEST AFTER 7 YEARS INTERMITTENT OPERATION, ROOTS #5 16 × 16", DIFFERENT MANUFACTURE THAN A & B 5.6 CU. FT./REV. DISPL.
FLUE GAS BLOWERS -
Ⓒ 5 × 11", 1/3 CU. FT. DISPL./REV. Ⓒ SAME SIZE - DIFF. MFR.
Ⓓ 5 × 15", 5/11 " " " - SAME MFR. AS Ⓒ - AV. OF 6.
Ⓔ 6 × 18, 3/4 " " " " Ⓒ
Ⓔ1 SAME SIZE AS Ⓔ, SAME MFR. AS C, & D AV. OF 6 TESTS.
Ⓕ 8 × 17", 1 1/4 CU. FT./REV.
NOTE: SIZE REFERS TO SHAFT SPACING AND LENGTH OF IMPELLERS, IN ORDER GIVEN.

Fig. 2—Slip curves of random "Roots" type blowers

the large machines used for pumping air, A, B and G, and the smaller blowers used for flue gas is that if we assume proportional dimensions, at any speed, pressure differential, and for any given set of clearances, the slip varies as the first power of a dimension, whereas the gross capacity varies as the cube of a dimension. It is therefore not surprising that the larger air blowers (A, B and G) have slip curves lying well above those for the smaller flue gas blowers. It is apparent that the manufacturer of blowers C and E used much closer clearances than did the maker of blowers C_1, E_1 and D. The difficulty in using blowers of the same nominal size that have such widely varying slip characteristics is that power estimates are likely to be wrong unless an efficiency test is run on each machine before the driver is ordered, which is seldom practicable. A motor found suitable for driving blower C at a given free air capacity would be too slow and might be too low in power to drive blower C_1 at the same delivery.

As slip is simply another expression for the volumetric efficiency of a Roots blower, we see that the overall efficiency of these machines will depend primarily on the size and the clearances used. In general, overall efficiency is lower for a Roots machine than for a rotary, sliding vane or a reciprocating, feather valve type of compressor, at all but very low-pressure differentials. Table I summarizes the results of five different efficiency tests on Roots blowers of a variety of sizes and of two different manufactures, for which slip data are given in Fig. 2. It will be noted that the large blower, which has close clearances for air service, shows an overall efficiency of 70 per cent, including the coupling loss, whereas the flue gas blowers of smaller size and greater clearance show efficiencies of 39 to 62 per cent, depending on the manufacture and operating conditions. Although it is customary for the builder to specify what power should be used, the buyer should check this recommendation to insure that the driver is not too large for the blower, and therefore costly and inefficient.

NOTES ON HANDLING HOT GASES. Greater end clearances than are usually allowed for cold service must be used if the outlet gas temperature is over about 250 deg. fahrenheit. Otherwise, the impellers may rub or seize, due to axial expansion. In applying cold slip data to hot working conditions, the observed slip must be corrected for actual inlet temperature under service conditions. An approximate method of computing the slip of a Roots blower operating at high suction temperature when the cold slip test data are available, is to multiply the cold slip at the working pressure differential by the square root of the ratio of the absolute temperatures of the suction under working and test conditions. For example, Fig. 2, blower F, shows a slip of 120 r.p.m. at 2½-lb./sq. in. differential. Assuming that the slip test was run at 80 deg. fahr., suction temperature, or 540 deg. absolute, the slip at 200 deg. fahr. or 660 deg. absolute will be

$$120 \times \sqrt{\frac{660}{540}} = 133 \text{ r.p.m.}$$

The increased slippage is, of course, due to the reduced specific gravity of the gas being by-passed back through the blower clearance. The above method is not exact, since the clearances change with large changes of temperature. However, it is seldom economical to run a shop slip test at other than room suction temperature.

For gas or air temperatures above 250 deg. fahr., changes are necessary in the design of bearings, lubrication system, and stuffing boxes. It is asserted by one manufacturer that with proper design, test and maintenance, Roots blowers can be operated successfully at 600 deg. fahrenheit. The question of water-jacketing naturally arises, and there are now some large air blowers operating at 15 lb./sq. in. differential that are water-jacketed. There are serious drawbacks to this practice. The time of contact between the cooled casing and the gases is too short to permit an appreciable fall in gas temperature in the blower, and there is no convenient way to water-

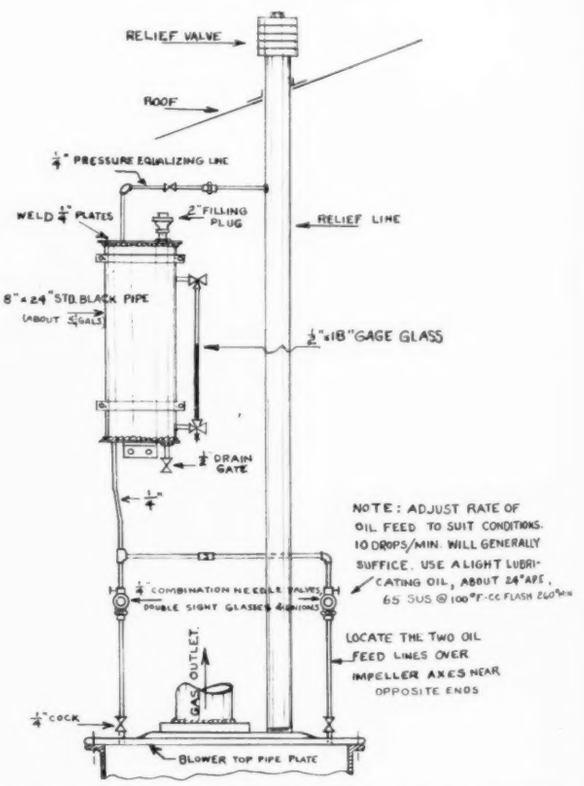

RELIEF VALVE
ROOF
¼" PRESSURE EQUALIZING LINE
WELD ¼" PLATES
2" FILLING PLUG
RELIEF LINE
8" × 24" STD. BLACK PIPE (ABOUT 5 GAL.)
½" × 18" GAGE GLASS
½" DRAIN GATE
¼"
¼" COMBINATION NEEDLE VALVES DOUBLE SIGHT GLASSES & UNIONS
NOTE: ADJUST RATE OF OIL FEED TO SUIT CONDITIONS. 10 DROPS/MIN. WILL GENERALLY SUFFICE. USE A LIGHT LUBRICATING OIL, ABOUT 24" API, 65 SUS @ 100°F. CC FLASH 260°MIN
LOCATE THE TWO OIL FEED LINES OVER IMPELLER AXES NEAR OPPOSITE ENDS
GAS OUTLET
¼" COCK
BLOWER TOP PIPE PLATE

Fig. 3—Internal oiling device for "Roots" type blowers

cool the impellers. Were hollow shafting to be used to conduct the cooling water, with suitable glands at ends of shafts, the cost of such a blower, already greatly increased by the water-jacketed casing, would become prohibitive. Disc type fans made of special metals are therefore preferable for handling hot gases, such as where recirculating flue gas in oil-still furnaces.

INSTALLATION, LUBRICATION AND MAINTENANCE. When the service is known to be corrosive, or when the Roots blower will be handling dust, soot or similar matter, the internal lubricating device shown in Fig. 3 will prove of value for reducing maintenance expense. A light oil of about 65 S.U.S. viscosity at 100 deg. fahr. is used, and the rate of feed is about ten drops per minute. As the oil is fed to both impellers and at opposite ends, there is a chance for the oil to work over the full area of impellers and casing, and keep solid matter from collecting and jambing the blower parts. Where the duty is intermittent, as for a purger used to make periodical inspections of the interior of a large gas holder, it is unnecessary to use a lubricator, the same result being attained by filling the blower casing with gas oil after each period of operation. The oil is, of course, drained out before the blower is again used.

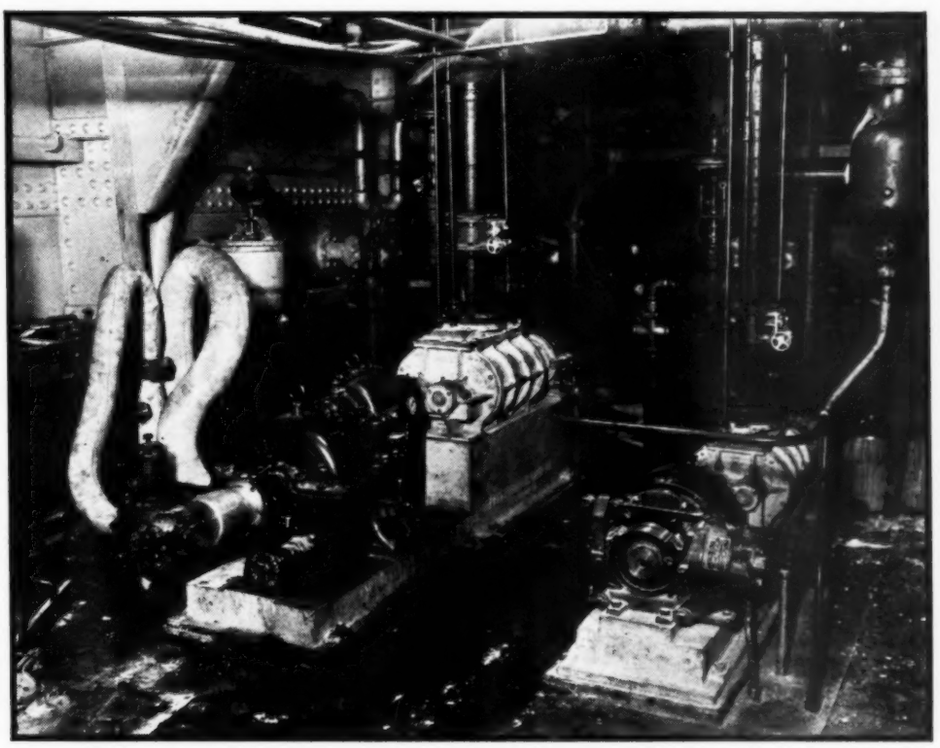
While operating, should any sign of a knock or undue heating develop, the blower should be stopped and the pipe plate on top removed, or the top section of casing lifted, to permit internal examination of impellers and casing, measuring clearances, cleaning, scraping, filing, etc. The impellers should be rotated slowly by hand, and any bright, worn spots noted. There should be no contact at any point between the impellers, or between impellers and casing. After extremely long service, the timing gears may wear enough to allow the impellers to knock, when gears should be renewed. When blower is open, signs of corrosion or pitting should be noted. If necessary to remove the impellers, care should be taken that end clearances are properly adjusted after reassembly. Dowells are provided in the casing for accuracy in assembling.

For Roots blower parts where there is serious corrosion, a relatively cheap, corrosion-resisting cast iron is available, costing for finished castings not over ten cents a lb. more than for ordinary cast iron. It is known under various names, such as "Ni-Resist" and "Causul" metal, and contains about 14 per cent nickel, 6 per cent copper and 1 or 2 per cent of chromium. For more severe service, it may be economical to use a non-ferrous alloy such as "Everdur," or to allow the ordinary cast-iron parts to corrode, keeping the machine free and retarding the corrosion rate with the internal lubrication system shown in Fig. 3.

Great care should be taken when first installing Roots blowers to insure that no strains are thrown on the blower top pipe plate and casing from the rigid piping system to which the blower is connected. The flange of the discharge pipe should be left free, and feelers used between this flange and the blower pipe flange, before bolting up. For small blowers, it is desirable to use a piece of rubber hose to connect the discharge system to the blower.

TYPICAL SPECIFICATIONS FOR TANK-SHIP FLUE GAS BLOWER. Supply one 6 x 18-in. blower suitable for pumping 500 cu. ft. per minute cooled, damp flue gas of about 1.04 specific gravity containing traces of soot and acid. The capacity is referred to 60 deg. fahr., and atmospheric pressure, and not to suction conditions. The blower will operate against a total maximum pressure differential of three lb./sq. in., one lb. (negative) suction pressure and two lb. discharge pressure. Suction temperature will not exceed 90 deg. fahr., and discharge temperature will not exceed 160 deg. fahrenheit. Casing and impellers to be of cast iron. Clearances will be such that not over 7½ hp. will be required at coupling to drive at above capacity. Motor or turbine driver will be supplied by buyer, and shipped to builder's shop for mounting. Certified prints of driver, including magnetic brake (or gear, in case of turbine) will be forwarded immediately to blower shop. Blower to be mounted on unit bedplate with driver, flexible coupling to be of the lubricated, Oldham type, and to be bored to suit driver.

Blower impellers should be balanced dynamically, to avoid



6x18-in. gas blower (left) for inert gas system installed in oil tanker. It is connected to 10-hp. turbine with built-in reduction gear, inlet on end of base and with opening in side for relief by-pass.

5x15-in. blower (right) driven by 3-hp. d.c. Note 8-in. shunt brake on motor.

vibration at operating speeds up to 900 r.p.m. Actual speed will be the nearest standard motor or turbine speed below 900 r.p.m. Standard flanged pipe connections to be provided to take 6-in. suction and 4-in. discharge pipes, the suction to be in end of bedplate, and the discharge on top of blower. The top pipe plate will also be drilled and tapped for one 2½-in. relief line and four ¼-in. pipe holes over the impellers, one at each end of each impeller, to be plugged in shop to keep out dirt.

Blower to operate quietly, without undue heating or knocking. Six outboard bearings to be used, of the double-roller, heavy-duty type, lubricated with standard Alemite fittings, bayonet joint type. An Alemite gun and hose will be provided with blower. Gears to be of the herringbone type, of cast iron, with gear case fitted for proper lubrication, including a sight glass, drain cock and extra large snap cover type filling oil cup. Blower shafts to be of ample diameter to resist torsional stresses, not less than 1½-in. in the glands; four stuffing boxes and ⅜-in. square-braided asbestos, graphite-impregnated packing are to be used. Stuffing boxes to be connected to suction side of blower by passages cored in the casing.

Blower to be equipped with a streamline body, double disc, spring-loaded diaphragm type relief valve of suitable size to pass the full flow of flue gas at 2 lb./sq. in. discharge pressure on blower when connected to 2½-in. blower pipe plate screwed connection, and to a total equivalent length of pipe of same size as valve of not less than 30 ft., including fitting allowances. (If desired, a non-chattering type weight-loaded relief valve of same capacity as above may be specified, to reduce first cost. If this is done, brass to iron sliding parts, and Alemite lubrication, should be specified).

Bottom of cast-iron bedplate to be planed, and at least six bolt holes not less than 1-in. diameter shall be drilled, or cast and reamed in base, for securing to ship's foundation. Bottom of base to be drilled and tapped for ½-in. drain connection, and hole plugged for shipment. Suitable pads must be cast and machined on base to take magnetic brake (or turbine gear, if steam drive is used).

Driver. Buyer will ship to builder's shop the following driver, which will be mounted on blower bedplate complete with lubricated flexible coupling to be supplied with blower.

(a) Steam Turbine. 7½-hp. single stage, non-condensing type, geared so as to be non-reversible, down to a blower speed of not less than 870 r.p.m. or more than 900 r.p.m. An overspeed trip and a constant speed governor to be provided. The nozzles to be divided, and one set equipped with a separate steam chamber and auxiliary valve, to insure economical operation at reduced speeds or powers. Steam packing, and gland leakoffs will be of approved types, and the turbine and gear lubrication will be approved. An instruction book will be provided with turbine for use by the engineer in charge of maintenance, and will include a list of spares recommended to be carried on board.

(b) D. C. Motor. 7½-hp. motor to be of the shunt-wound type, voltage to suit power circuits of vessels, semi-enclosed, drip-proof, ventilated, variable-speed, marine type. Temperature rise not to exceed 55 deg. cent., or motor to be suitable for continuous operation at a total motor temperature of 203 deg. fahr. at full load in an ambient of 40 deg. cent. (104 deg. fahr.) r.p.m. to be next standard below 900 (approximately 870). Double shaft extension to be used, the end opposite coupling to be machined to suit magnetic brake. Motor starter to be of the push button and relay box type, and shunt field rheostat will be provided for motor speed control down to about 600 r.p.m., a series rheostat being used for control below this point. Relay box to include a special contactor to insure that magnetic brake will release promptly and completely when starting. Magnetic brake will be of the shunt type, drum not under 8-in. diameter, with suitable adjustment for tension when closed, and friction shoes of suitable material to avoid scoring or slipping of drum. Spares for motor and brake to be recommended by the makers.

NOTES ON SPECIFICATIONS. The magnetic brake or the non-reversible turbine gear feature in the above specifications is to prevent reversal of flow, from the space being purged back to the source of gas. There are ample precautions aside from this, but it is desired to insure that the blower cannot start up backward, thus placing a positive stop in the line. As Roots blowers are used as gas meters under an inch of water or so of pressure differential, they will turn over with very little back pressure if not restrained. Perhaps with the motor or turbine friction and the gland friction of blower, a pound pressure would be required to reverse the blower, if not restrained by motor brake or turbine gear.

On shore, it is customary to use a-c. motors with no speed control, the excess gas merely wasting to the air when full capacity is not required, and blower discharge is throttled accordingly. A simple, cheap, across-the-line starter can be used for motors up to about 20 hp., depending on voltage and speed, and upon motors protected by metal weather boxes slotted for shafts can generally be used. Due to the proximity of the furnace used to produce the gas, there is no advantage in using vapor-tight motors, although these may be indicated for dusty atmospheres. No magnetic brake is generally fitted on shore motors. The motor must be guaranteed to draw less starting current than the limits prescribed by the National Electric Light Association.

NOTES ON SHOP TESTING. A shop test of at least one hour's duration in the presence of the buyer should be run at full speed and full pressure differential, followed by the slip test. The pressure in blower discharge should be measured with a mercury manometer, and the suction left free. Temperatures of room and of gas in blower discharge should be recorded, the latter by using a well in blank. Speed should be taken exactly for each test, and where there is provision for measuring power conveniently, an efficiency test under full speed and pressure differential should be included with tests.

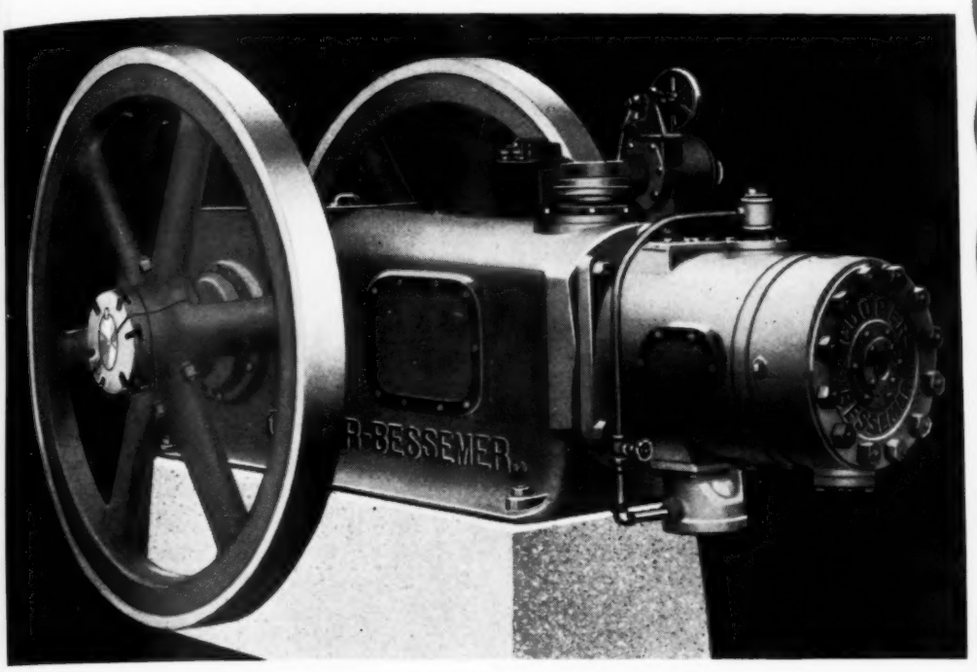
The inspector should make sure the glands are not too loose, and that the bearings, gears and blower casing are properly lubricated. If desired to simulate the operating conditions, a pint of light oil can be poured into the blower discharge while turning over the blower by hand, just before tests. During tests, feel all parts of casing and stuffing boxes for heating; and holding the ear pressed against the hand laid hard on the casing, listen for knocking and gear clash.

If capacity of blower and other features are acceptable, blower should be sealed up for shipment in the presence of the inspector. All holes must be blanked, to prevent foreign particles from entering. On the job, before blower is ever run under power, it must be turned over several times by hand to insure that nothing has fallen into the casing during installation.

This is the concluding article on Roots type blowers.

—EDITOR.

THE MARCH OF PROGRESS HAS NEVER STOPPED AT COOPER-BESSEMER

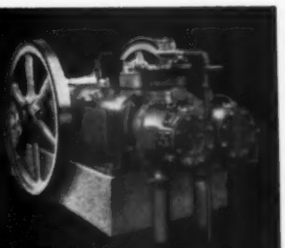


Large illustration shows G-AO two-cycle pumping engine 40 to 70 H. P., can be equipped with gas economizer where fuel costs warrant it, or can be converted to Diesel oil engine at any time.

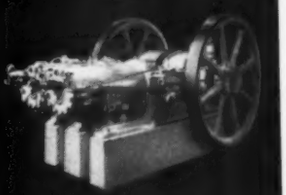
ALL during the depression years Cooper-Bessemer engineers have been devoting their time to engine development. They have designed and refined more new types and sizes in the last four years than in any previous similar period in their one hundred and one years of engine building experience.

There has always been the firm conviction here that the demand for the cheapest and most reliable source of power (Gas and Diesel Engines) would be greater than ever during the new upswing. The necessity for keeping costs down in the face of higher labor rates makes low cost gas or Diesel engine power more attractive than ever.

Cooper-Bessemer is ready with the most complete line of both two and four-cycle horizontal and vertical gas engines from 20 to 1600 horse power and Diesel engines from 25 to 1300 horse power for every conceivable power purpose. You can safely follow Cooper-Bessemer's recommendation on any power problem.



G-AW twin-cylinder 100 to 140 H. P. two-cycle gas engine, can be equipped with gas economizer where fuel costs warrant it, or can be converted to full Diesel oil engine.



Type GD engines are two-cycle horizontal for general power applications, and are built in single and twin-cylinder sizes from 70 to 200 H. P.

THE COOPER-BESSEMER CORPORATION

PLANTS: MT. VERNON, OHIO GROVE CITY, PA.

DISTRICT OFFICES

25 West 43rd St., New York City
53 Duncan St., Gloucester, Mass.
201 E. First St., Tulsa, Okla.
817 Mills Bldg., Washington, D. C.
1314 Magnolia Bldg., Dallas, Texas
225 Crockett St., Shreveport, La.
Grove City, Pennsylvania
640 E. 61st St., Los Angeles, Cal.
505 Esperson Bldg., Houston, Texas

Oil Well Pumping in The East Texas Field

By J. E. ELLIOTT
Southwestern Gas & Electric Co.
Shreveport, Louisiana

THE problem of oil well pumping in the East Texas oil field is one that has been given considerable thought and attention by petroleum engineers, operators, equipment manufacturers, and power companies who have invested a large sum of money in transmission and distribution lines in the field and power plant capacity in order adequately to serve the operators and oil companies with a continuous supply of electric power.

Coupled with the general conditions in the oil business, the uncertainty makes it imperative that oil companies exercise unusual care in the selection of equipment and the form of power to be used. The small margin of profit under present operating conditions makes it advisable for operators to adopt efficient pumping methods. Present economic conditions make it important for oil companies to give considerable thought to operating costs. In making comparative estimates, all the costs incidental to all forms of power should be taken into consideration.

Oil companies and operators are inclined not to give due consideration to fixed charges in their operating problems, i.e., depreciation, taxes, and insurance. Those considering these fixed charges are prone to use an extremely low rate of interest and depreciation. Equipment depreciates or becomes obsolete over a period of time; as for example, an automobile purchased in 1920 at a cost of $2000 would today probably be worth less than $50, even though it has been driven into a garage at the time of its purchase and never been operated. Pumping equipment should carry a relatively high depreciation charge, due to the short life of the average oil field, and particularly due to the severe service to which it is subjected. Ten per cent per annum is a conservative figure for the depreciation of pumping equipment. An interest charge is usually made when money is borrowed, this charge usually being seven per cent per annum. When an operator invests his money in pumping equipment, interest constitutes a part of the fixed charges. Taxes and insurance must be paid, averaging three per cent per annum on the total investment. Therefore, fixed charges on pumping equipment should be approximately 20 per cent—composed of depreciation ten per cent, interest seven per cent, and taxes and insurance three per cent.

If it costs Mr. A, Mr. B, and Mr. C, $10,000, $5000 and $2000, respectively to equip their wells for pumping, and assuming a fixed charge of 20 per cent per annum; Mr. A's fixed charge per year is $2000, Mr. B's is $1000, and Mr. C's is $400. The difference between Mr. A's and Mr. C's fixed charges is $1600 and will pay for Mr. C's investment in one year and three months. The difference between Mr. B's and Mr. C's is $600 and will pay for Mr. C's investment in three years and four months.

Several operators have equipped their wells in East Texas with pumping equipment sufficiently large to handle any contingencies; some wells being equipped at a cost of $10,000. It was their belief when this equipment was installed that eventually they would be required to pump a large quantity of oil or fluid per day. They believed, too, that the East Texas field would not be produced differently from that of any other field, and from past experience they had found it advisable to equip with heavy-duty pumping equipment. Experience in the East Texas field has caused many to believe this is very unlike other oil producing fields of the past, in that wells capable of producing several thousand barrels of oil per day are allowed to produce only a small percentage of their hourly potential. This condition has existed, to a marked degree, since the discovery of this field.

The installation of a large unit to pump a few barrels of oil per day seems out of proportion, consequently, due to the uncertainty of proration and water encroachment, many operators have installed large pumping units with a back crank to which pull-rod connections may be attached, and additional wells pumped by jacks. A pitman connection has also been devised whereby one or two additional wells may be pumped without the use of a back crank.

A number of central pumping powers have been installed along the extreme east edge of the field. The use of powers for pumping is limited to the number of wells and their relative location. The surface equipment will not permit the pumping of large volumes of fluid. The average cost per well, equipped for pumping with a central power, is $2000. Several central powers have been installed in East Texas for pumping from 10 to 15 wells, at a total cost varying from $20,000 to $30,000. A few have been installed more than two years, and it has only been necessary to pump, or agitate, one or two wells a few minutes per day.

When well servicing and clean-out work is to be performed by auxiliary portable equipment, many operators have equipped their wells with a highly efficient electric gear-driven pumping unit at an overall cost of approximately $2,000. These units are capable of pumping between 400 and 600

are you going to do 1935?

TAKING shape on the drafting boards of power plant engineers are engines that will make obsolete the new wonders America is acclaiming today.

Some of these projected power plants will be born for success.

Because it is your intention to build one which will be successful, and because power increases will probably help toward that end, we print this resume:

Power history—what is it?

On the opposite page, chart "A" illustrates the steadily increasing horsepower of the average American car. It also points out the component factors which caused this general increase.

That is for the *average* car—all cars.

Who made the increases?

Ninety-four per cent of all cars sold in 1933 bore one of 12 nameplates, and their power history is even more pointed. Most of them showed horsepower gains for both 1933 and 1934, considerably greater than the averages indicated in chart "A."

Of the 21 different models made under the 12 names mentioned, 19 were more powerful in 1933 than they were in 1932, and 18 are more powerful in 1934 than in 1933. The average gain per model for the two years was 14.4 horsepower.

Apparently, people who buy automobiles like power and MORE power. Certainly, that idea seems to have occurred to the makers of these successful cars.

How were the power gains made?

In fundamental terms, there are only three ways to increase engine power. These factors may be expressed in simple algebraic form:

$$\text{Horsepower} = \frac{\text{B.M.E.P.} \times \text{Displacement} \times \text{R.P.M.}}{792{,}000}$$

Any increase in horsepower for *your* 1935 car will come from an increase in one or more factors in the numerator above.

Greater Displacement?

Bigger engines mean longer and heavier chassis, more difficult cooling problems, lower cyclic efficiency, consequently: increased gasoline consumption, and comparatively low performance gains in proportion to power gains.

More Revolutions per Minute?

More revolutions per minute produce desirable results; however, they involve penalties which become increasingly significant as higher speeds are reached. Even increases of comparatively small magnitude normally require changes in one or more of the following features: camshafts, bearings, ignition systems, pistons, piston rings, connecting rods, valves, valve springs, carburetion, manifolding, cooling and lubrication.

Higher B. M. E. P.?

Three out of four cars that have made power gains in the past two years got the added power, in whole or in part, through higher compression ratio. That is, of course, the easy, cost-less way to increase brake mean effective pressure. An example of the effects of increased compression on power and economy is shown in chart "B."

Another way of increasing brake mean effective pressure, which will be particularly helpful to those cars which already have the higher compression ratios, is improved volumetric efficiency. An example of the horsepower gains to be made in this manner is indicated in chart "C."

Fuel of sufficiently high anti-knock value to permit substantial increases in the brake mean effective pressures of most engines is available today in nearly every filling station in the United States and Canada.

Engineers of the Ethyl Gasoline Corporation will be glad to cooperate with you in any research or testing that may prove helpful in improving performance of your 1935 cars.

bbl. of oil per day from a depth of 3600 feet. A number of these have been installed in East Texas, due to their high efficiencies, low maintenance, and low first costs, and particularly because the operators believed these units would be of sufficient capacity to pump their wells for several years, or to the extent that the difference between the fixed charges on an installation of this kind and a more expensive installation would pay for the unit and, in time, leave the operator with a sufficient profit to install the heavier equipment, should it become necessary. By installing a unit of this type, a group of wells can be equipped as pumping or agitating may become necessary. In the case of an operator who has elected to equip with a central power, approximately 50 per cent of the total first cost for equipping the wells (power unit and prime-mover) must be made when possibly only one well in the group may require agitating or pumping.

The question of how best to pull the rods and tubing has been given considerable thought by oil operators. Formerly wells have been equipped with a motor or engine of sufficient size to carry the larger load required for servicing. This has required a higher investment per well with a sacrifice in operating efficiencies. As the power equipment is used relatively little for servicing the well, and the major purpose is for pumping, it seems to be feasible to equip the well with a highly efficient pumping unit without regard to hoisting equipment. The well servicing can then be taken care of through a separate portable winch. Portable pulling equipment is very popular at the present time, but individual well-pulling equipment is desirable in some instances.

There is a question regarding whether or not a large volume of salt water will be pumped in the East Texas field as there has apparently been no feasible solution offered for disposing of any appreciable amount of the water that might be produced. Reservoirs would be too large for practical use, a separate pipe line to the coast would be very costly, and the Sabine River is used for a water supply for many towns between the field and the coast and for irrigation purposes, fishing, and for watering livestock. While it is possible a solution may be found for disposing of the salt water, it apparently seems inadvisable to equip the individual wells at present with heavy-duty pumping equipment, when the allowable can be produced with five or six horsepower in only a few hours' pumping time. Unless a method is found for disposing of the salt water, skimming of the wells may probably result.

The present allowable for East Texas is approximately 400,000 bbl. per day. It has been as high as 800,000 barrels. There are now more than 12,000 wells in the field, and the number of producing wells is increasing at a rapid rate. The present average well-producing acreage is less than ten acres per well, and there is no sign of a decrease in drilling. As the field becomes depleted, it is likely that wells will be plugged or abandoned. The following table shows the average daily allowable of oil per well per day, based on 15,000, 12,000, 10,000, 8,000, and 4,000 producing wells, and total allowables for the field of 400,000 bbl., 600,000 bbl. and 800,000 bbl. daily.

Number of Producing Wells	Daily Average Allowable per Well Based on 400,000 bbl. for the Field	Daily Average Allowable per Well Based on 600,000 bbl. for the Field	Daily Average Allowable per Well Based on 800,000 bbl. for the Field
15,000	27	40	44
12,000	33	50	66
10,000	40	60	80
8,000	50	75	100
6,000	66	100	133
4,000	100	150	200

Fluid levels in the wells in East Texas are relatively high, and pumping from the bottom of the well may not be necessary, except in a few cases, for some time. Several operators believe that the fluid level will be sufficiently high in a large percentage of the wells during the next five years for them to flow with slight agitation.

The average depth of the wells in East Texas is 3600 ft.; a barrel of 42-gravity crude oil weighs approximately 300 lb.; the amount of work, therefore, required to lift one barrel of oil from the bottom of the well to the surface is:

$$300 \text{ lb.} \times 3600 \text{ ft.} = 1{,}080{,}000 \text{ ft. lb.}$$

This is based on 100 per cent overall efficiency and, neglecting any influencing factors, such as gas in solution that would tend to decrease the amount of work required.

1 Kw-hr. = 2,654,000 ft. lb.

$$\text{Kw-hr. required to lift one bbl. of oil 3600 ft.} = \frac{1{,}080{,}000}{2{,}654{,}000} = .407$$

In performing this work mechanically, there results a loss in efficiency in which the actual power input varies in proportion to the overall efficiency.

KW-HR. REQUIRED TO LIFT ONE BBL. OF 42-GRAVITY OIL

Overall Eff.	3600 ft.	3000 ft.	2000 ft.	1000 ft.
100%	.407	.339	.226	.113
80%	.510	.423	.282	.141
70%	.574	.483	.322	.161
60%	.680	.564	.376	.188
50%	.817	.678	.452	.226
40%	1.020	.846	.564	.282
30%	1.360	1.128	.752	.376

Assuming an overall efficiency of 50 per cent from the above table, .817 kw-hr. is required per barrel of oil pumped from 3600 ft.; .452 kw-hr. from 2000 ft.; and .226 kw-hr. from 1000 feet.

The power required per barrel of fluid will increase if water is pumped, but any increase in power, due to the pumping of water, is offset to a certain extent by the low overall efficiency that has been assumed. The overall efficiency of a gear-driven pumping unit is approximately 70 per cent.

The following tables show the cost of electric power per month for pumping different quantities of oil, varying from 600 to 3000 bbl., from a depth of 1000 ft., 2000 ft., and 3600 ft. with an overall efficiency of 50 per cent, calculations being made on an energy cost of .9 cents, 1 cent, 1.5 cents, and 2 cents per kw-hr.

National Seamless Casing

Pierced from solid steel!

No chance—no uncertainty about the uniform wall strength of NATIONAL A. P. I. Diamond BX and B8 Seamless Casing! One continuous piece of steel pierced from the solid—expanded and rolled at temperatures which produce grain refinement and uniform transverse and longitudinal strength. A balanced, homogeneous unit—unsurpassed from a manufacturing standpoint. Tried and tested under every known service condition, it has the unqualified approval of operators and casing crews. Smooth running and greater security have made NATIONAL Seamless—

America's Preferred Casing

NATIONAL TUBE COMPANY · PITTSBURGH, PA.

SUBSIDIARY OF UNITED US STATES STEEL CORPORATION

COST OF PUMPING OIL FROM A DEPTH OF 1000 FEET

Barrels Pumped per Day	Barrels Pumped per Mo.	Kw-hr. per Mo. at .226 per Bbl.	Cost of Electric Power per Month			
			.9c per Kw-hr.	1c per Kw-hr.	1.5c per Kw-hr.	2c per Kw-hr.
20	600	136	$ 1.22	$ 1.36	$ 2.04	$ 2.72
25	750	170	1.53	1.70	2.55	3.40
30	900	203	1.83	2.03	3.05	4.06
35	1050	237	2.13	2.37	3.56	4.74
40	1200	271	2.44	2.71	4.07	5.42
45	1350	305	2.75	3.05	4.58	6.10
50	1500	339	3.05	3.39	5.09	7.78
60	1800	407	3.66	4.07	6.11	8.14
70	2100	475	4.28	4.75	7.13	9.50
80	2400	542	4.88	5.42	8.13	10.84
90	2700	610	5.49	6.10	9.15	12.20
100	3000	678	6.10	6.78	10.17	13.56

COST OF PUMPING OIL FROM A DEPTH OF 2000 FEET

Barrels Pumped per Day	Barrels Pumped per Mo.	Kw-hr. per Mo. at .452 per Bbl.	Cost of Electric Power per Month			
			.9c per Kw-hr.	1c per Kw-hr.	1.5c per Kw-hr.	2c per Kw-hr.
20	600	271	$ 2.44	$ 2.71	$ 4.07	$ 5.42
25	750	339	3.05	3.39	5.09	6.78
30	900	407	3.66	4.07	6.11	8.14
35	1050	473	4.26	4.73	7.10	9.46
40	1200	542	4.88	5.42	8.13	10.84
45	1350	610	5.49	6.10	9.15	12.20
50	1500	678	6.10	6.78	10.17	13.56
60	1800	814	7.33	8.14	12.21	16.28
70	2100	949	8.54	9.49	14.24	18.90
80	2400	1085	9.77	10.85	16.28	21.70
90	2700	1221	10.99	12.21	18.32	24.42
100	3000	1356	12.20	13.56	20.34	27.12

COST OF PUMPING OIL FROM A DEPTH OF 3600 FEET

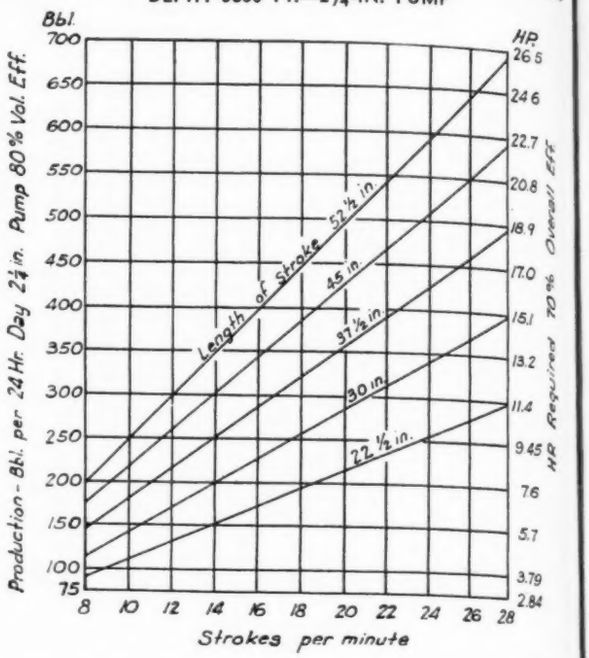
Barrels Pumped per Day	Barrels Pumped per Mo.	Kw-hr. per Mo. at .817 per Bbl.	Cost of Electric Power per Month			
			.9c per Kw-hr.	1c per Kw-hr.	1.5c per Kw-hr.	2c per Kw-hr.
20	600	490	$ 4.41	$ 4.90	$ 7.35	$ 9.80
25	750	613	5.52	6.13	9.20	12.26
30	900	735	6.62	7.35	10.98	14.70
35	1050	858	7.72	8.58	12.87	17.16
40	1200	980	8.82	9.80	14.70	19.60
45	1350	1103	9.92	11.03	16.55	22.06
50	1500	1226	11.03	12.26	18.39	24.52
60	1800	1571	14.14	15.71	23.57	31.42
70	2100	1716	15.44	17.16	25.74	34.32
80	2400	1961	17.24	19.16	27.74	38.32
90	2700	2206	19.85	22.06	33.09	44.12
100	3000	2451	22.06	24.51	36.77	49.02

In the event it should become necessary to pump an appreciable amount of salt water to obtain the daily allowable from a depth of 3600 ft., it is estimated that the power required will not exceed one kw-hr. per bbl. of fluid lifted. It is further estimated that the power requirements will not exceed one kw-hr. per bbl. of fluid lifted with the application of electric motors to standard rigs for pumping.

COST OF PUMPING FROM A DEPTH OF 3600 FEET
Calculations Based on One Kw-hr. per Bbl. of Fluid Lifted

Barrels Pumped per Day	Barrels Pumped per Mo.	Kw-hr. per Mo. per Bbl.	Cost of Electric Power per Month			
			.9c per Kw-hr.	1c per Kw-hr.	1.5c per Kw-hr.	2c per Kw-hr.
20	600	600	$ 5.40	$ 6.00	$ 9.00	$12.00
25	750	750	6.75	7.50	11.25	15.00
30	900	900	8.10	9.00	13.50	18.00
35	1050	1050	9.45	10.50	15.75	21.00
40	1200	1200	10.80	12.00	18.00	24.00
45	1350	1350	12.15	13.50	20.25	27.00
50	1500	1500	13.50	15.00	22.50	30.00
60	1800	1800	16.20	18.00	27.00	36.00
70	2100	2100	18.90	21.00	31.50	42.00
80	2400	2400	21.60	24.00	36.00	48.00
90	2700	2700	24.30	27.00	40.50	54.00
100	3000	3000	27.00	30.00	45.00	60.00

EAST TEXAS PRODUCTION AND HP. REQUIREMENTS—PUMPING DEPTH 3600 FT.—2¼-IN. PUMP



ELECTRIC POWER COST PER MONTH FOR EAST TEXAS

Kw-hr. Demand	Kw-hr. per Mo.	Electric Power Cost per Month		No. Bbls. Pumped per Month
		Rate 1c per Kw-hr.	Rate 1½c per Kw-hr.	
19.8	14,300	$143.00	$211.50	21,000
18.4	13,250	132.50	198.75	19,500
16.9	12,150	121.50	182.25	18,000
15.5	11,150	111.50	167.25	16,500
14.1	10,150	101.50	152.25	15,000
12.7	9,150	91.50	137.25	13,500
11.3	8,150	81.50	122.25	12,000
9.7	6,975	69.75	94.62	10,500
8.5	6,100	61.00	92.00	9,000
7.0	5,050	50.50	75.75	7,500
5.7	4,100	41.00	61.50	6,000
4.3	3,140	31.40	47.10	4,500
2.8	2,200	22.00	33.00	3,000

The cost of electric power to many operators, is thought of in terms of operating costs only. Our experience would lead us to believe that proper thought is not given to the various items of expense that are covered by an electric power bill. Operating cost items may perhaps be distributed to several separate accounts so that unless they are especially compiled, their full significance is not always appreciated. If the production man could have a summary of all these items at the time the power bill is presented, he would get a truer picture of production costs.

Electric motors have a direct bearing on rod and rig maintenance. When the rods have completed their travel on the downward stroke and have started up with the fluid, it is characteristic of the electric motor to slow down, then accelerate gradually up to speed.

Records indicate that the average shut-down time from all causes for an electric-motor-driven pumping installation is extremely low. It is granted that in a prorated field like East Texas where the allowable can be produced in less than 24 hours, the effect on production due to shut-down time is of slight importance. However, should the wells go on a 24-hour pumping basis, this item should receive serious consideration.

There are three principal classes of electric motors used in the pumping of oil wells: first, a constant speed single-rated squirrel cage induction motor for pumping purposes only; second, the oil field type motor double-rated 15/30-hp., 15/65-hp., etc., 600 to 1200 r.p.m., with varying speeds, the low side being used for pumping, the high side for pulling rods and tubing, and general servicing of the well; and third, the Y-Delta type of motor, constant speed double-rated for pumping and servicing, and to give power flexibility to take care of fluctuating conditions of the pumping load where even greater flexibility is required, a triple-rated constant speed Y-Delta, Internal-Delta may be used. There is, for instance, one motor available with a rating of 9/16/25 horsepower. Such a motor can be operated as a 9-hp. motor, a 16-hp. motor, or a 25-hp. motor by merely throwing the switch, which is part of the equipment. This motor can be obtained with a speed of 600, 900, 1200, and 1800 r.p.m. The motor operating on the 9-hp. rating will have a high efficiency for a load as low as five or six horsepower. In the early pumping stages, it may be desirable to operate on the 9-hp. rating. As the amount of fluid to be pumped increases, resulting in a corresponding increase in the horsepower requirements, the motor can be changed to operate on the 25-hp. rating. By such a method high efficiencies can be obtained from 5 hp. through approximately 27 hp., allowing for a slight overload on the motor.

The cost of equipping an oil well for individual pumping in East Texas varies considerably. It is dependent to a great extent upon the size or capacity of the unit installed.

The following cost estimate is based on equipping and pumping a well with a double reduction motor-driven gear unit, capable of pumping between 400 and 600 bbls. per day from 3600 feet. The cost of the unit is the average price of a number of highly efficient units. A totally enclosed electric motor has been included, which eliminates the necessity of a motor house. Servicing the well to be performed by portable equipment.

Labor costs were not included in this estimate as this cost would depend upon the number of wells a pumper could handle. Records indicate that one pumper can look after 20 electrically-pumped wells.

The electric power consumption per month has been based on an overall efficiency of 50 per cent, i.e., .226, .452, and .817 kw-hr. per bbl. pumped from 1000, 2000 and 3600 ft. respectively, with an energy charge of one cent per kw-hr., which is the average rate earned for simultaneous demand and energy by a number of companies. For one well the rate would be slightly in excess of one cent per kw-hr.

The present average daily allowable per well is 33 barrels. Calculations in this estimate are made on pumping 50 bbl. per well per day. It is doubtful that the daily per well allowable will exceed this amount for several years. Consequently 50 bbl. is a fair figure upon which to make calculations.

First Cost

Double reduction unit, including post beam, pitman, crank, counterbalance, and V-belt drive	$1,825.00
Electric motor, 9/16/25 Hp. (outdoor type)	275.00
Foundations, installation, and wiring	150.00
Total First Cost	$2,250.00

Fixed Charges—Annual

Depreciation, interest, taxes, and insurance (20%) ($2,250.00 × 20% =	$ 450.00

Operating Cost

50 Bbl./Day—1500 Bbl./Month

	Pumping Depth 1000 ft.	2000 ft.	3600 ft.
Electric power cost based on .226, .452, .817 kw-hr. per bbl. pumped from 1000, 2000, and 3600 ft. Energy calculated at 1c per kw-hr.	$ 3.39	$ 6.78	$12.26
Total Monthly Cost:			
Electric Power	3.39	6.78	12.26
Labor (dependent on number wells)	.....	.....	.....
Maintenance per month at $48.00 per year	4.00	4.00	4.00
Fixed charges per mo.— $\frac{\$450.00}{12} = \$31.50$	31.50	31.50	31.50
Total Cost— Fixed and Operating	$38.89	$42.28	$47.76

Estimated first cost of equipping a well with a double reduction gear and an electric motor capable of pumping approximately 1000 bbl. per 24 hours from 3600 feet.

Electric Motor Installation

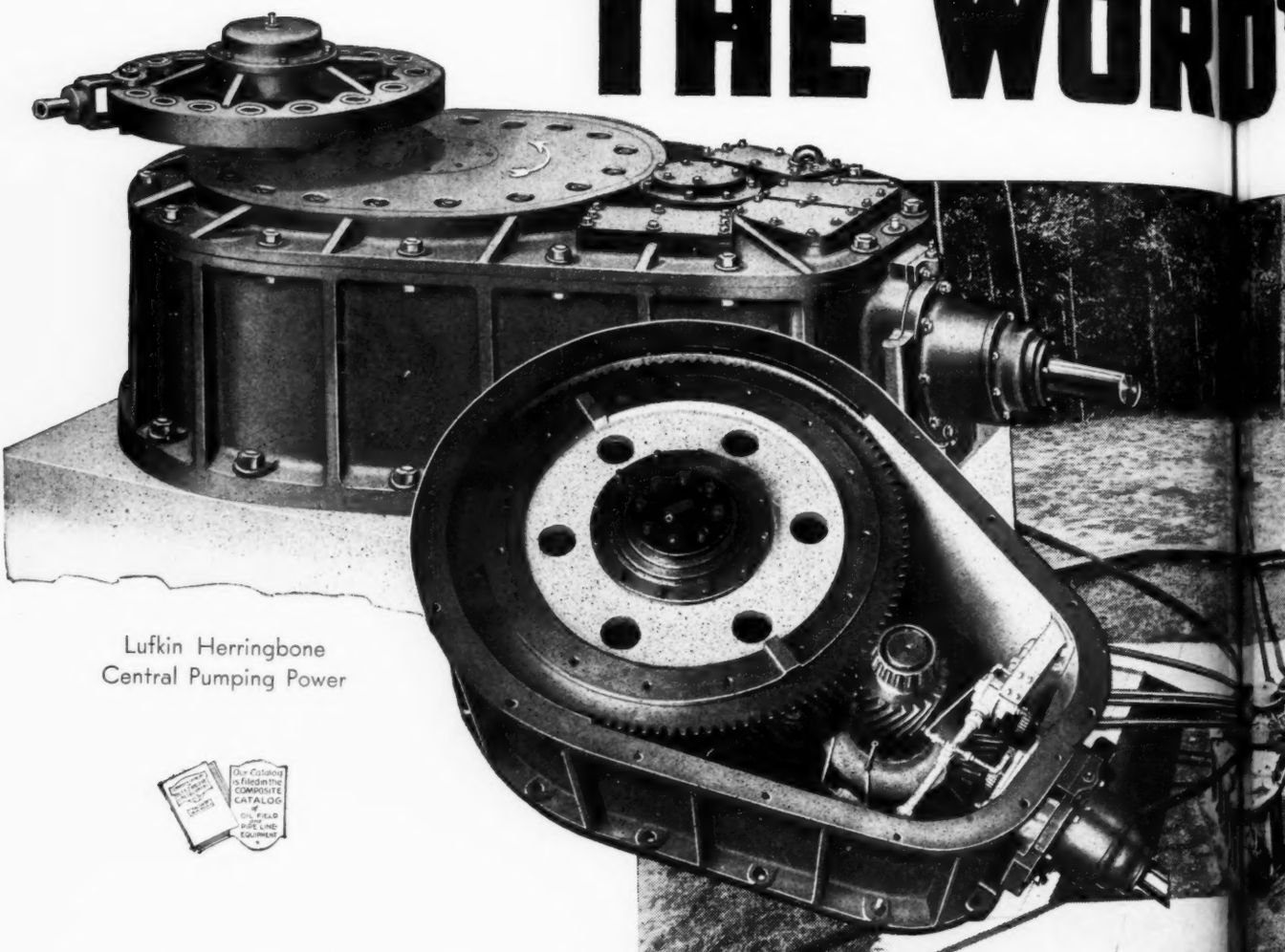
Double reduction gear	$1,700.00
V-belt drive	140.00
Counterbalance	216.00
Post beam and pitman (installed)	700.00
Install gear	200.00
Electric motor, 15/40 hp., 440 volt, 3-phase, totally enclosed out-door type with reversing control	404.00
Install motor and wiring	100.00
Teaming	40.00
Total	$3,500.00

Estimated first costs of equipping ten wells with an electric motor on a central power.

Electric Motor

10-Jacks and rod lines at $750.00 per well	$7,500.00
1-Central power	4,000.00
1-Electric motor, 100 hp.	750.00
1-Motor house	400.00
1-Foundation	75.00
1-Erection and wiring	125.00
1-Trucking	75.00
Total	$12,925.00

THE WORD



Lufkin Herringbone
Central Pumping Power

Brief Outstanding Characteristics of the Lufkin Herringbone Central Power No. 150

1.—150 H. P. at 20 S. P. M.
2.—42" Stroke (Minimum surface strain).
3.—COMPACT—shortest possible lever arms to bearings and foundation.
4.—Center trunion designed for shocks—no strain on crank or base.
5.—Ample bearings—TIMKEN throughout.
6.—HERRINGBONE GEARS—Thrust eliminated.
7.—Gleason Helical Bevels—the finest made.
8.—Crank and Crank Pin cast integral of Alloy Steel.
9.—Crank Disc equipped with large bronze bushed take-offs.
10.—Pressure pump lubrication—Positive.

Lufkin H. B. Central Power Installation

Lufkin Central Powers are made in Lufkin, Texas, by

LUFKIN FOUNDRY & MACHINE COMPANY

Machinery Manufacturers Since 1900

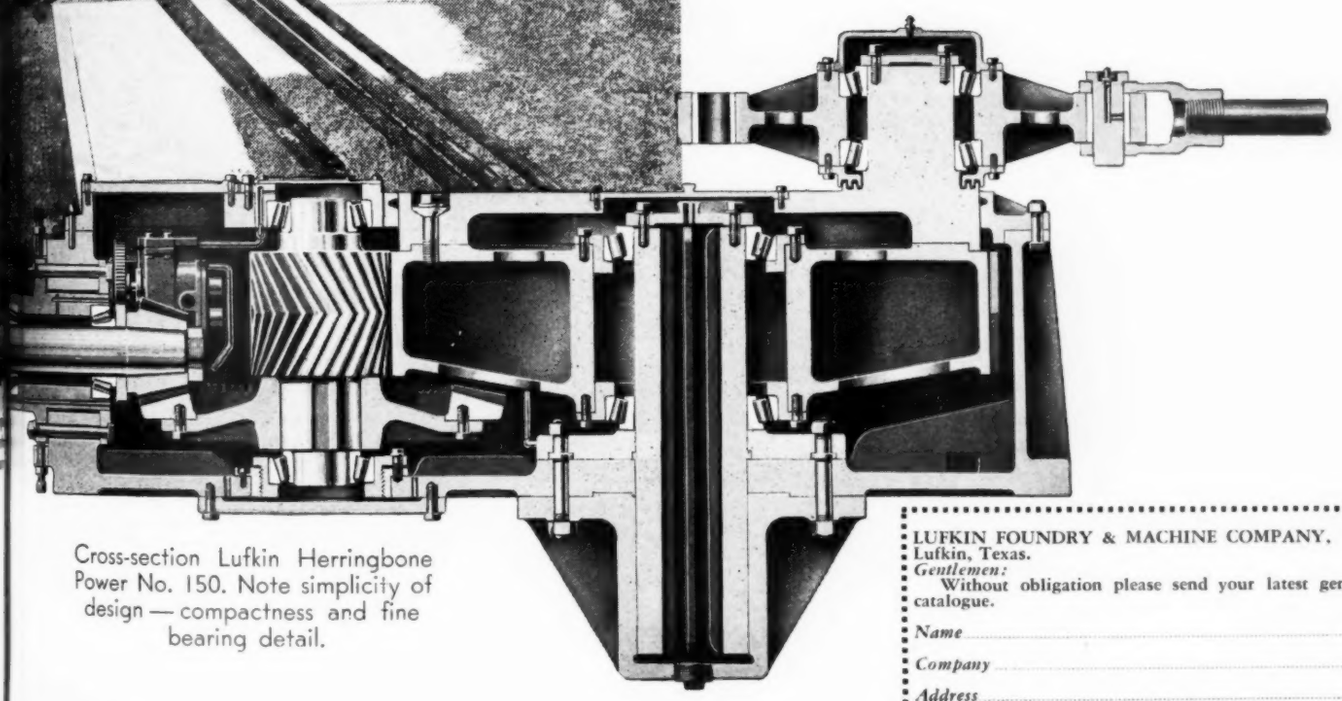
RD'S *Greatest..!*

• • • Greatest Horsepower Capacity

• • • Greatest Strength

• • • Greatest Stroke Length

• • • Greatest Obtained Compactness



Cross-section Lufkin Herringbone Power No. 150. Note simplicity of design — compactness and fine bearing detail.

LUFKIN FOUNDRY & MACHINE COMPANY,
Lufkin, Texas.
Gentlemen:
Without obligation please send your latest general catalogue.

Name .....
Company .....
Address .....
Position ..... *Special Data on* .....

Engineering Fundamentals Department

- A Study Course for Field and Plant Men
- A Review for Experienced Engineers

W. L. NELSON
K. C. SCLATER
Editors

Elements of Applied Production

By K. C. SCLATER

Article 5

EQUIPMENT AND OPERATION OF OIL WELLS (Continued)

Naturally Flowing Wells (Continued)

FLOW LINES. These are the lines from the well-head to the oil and gas separator through which a flowing well produces. Flow lines on average flowing wells range in diameter from two to four inches. On large wells, especially those producing through the casing, 6-in. flow lines are not uncommon.

Well conditions will determine the proper size and number of flow lines that should be employed. For a small flowing well producing through the tubing a single 2-in. flow line may be ample. In high-pressure fields, however, where the wells are large potential producers, it is common practice to have at least two flow lines from the casing to a point just outside the derrick, and, if the wells are tubed, two similar short flow lines from the tubing. Each flow line should have an adjustable flow bean or choke nipple, which is placed in the flow line as close as possible to the casinghead or the Christmas tree.

When four or more flow lines are employed in this manner, a manifold is placed just outside the derrick, from which point only two flow lines run to the separator, one for the tubing flow and one for the casing flow. Valves are placed in the flow lines so that any line can be shut off or opened as desired.

Unlike the Christmas tree, which for high-pressure work is usually made up and tested in the shop to at least twice the maximum working pressure, the derrick flow-line manifold is usually made up in the field with high-pressure fittings.

Both the casing and tubing flow lines should have a connection so the flow can be diverted to a sump or settling tank to clean the well of mud when it is brought in or during subsequent cleaning-out operations, repair work, or in case the well starts producing large quantities of sand with the oil. The flow lines are the main outlet of the well and, at high-pressure wells especially, every possible emergency should be provided for.

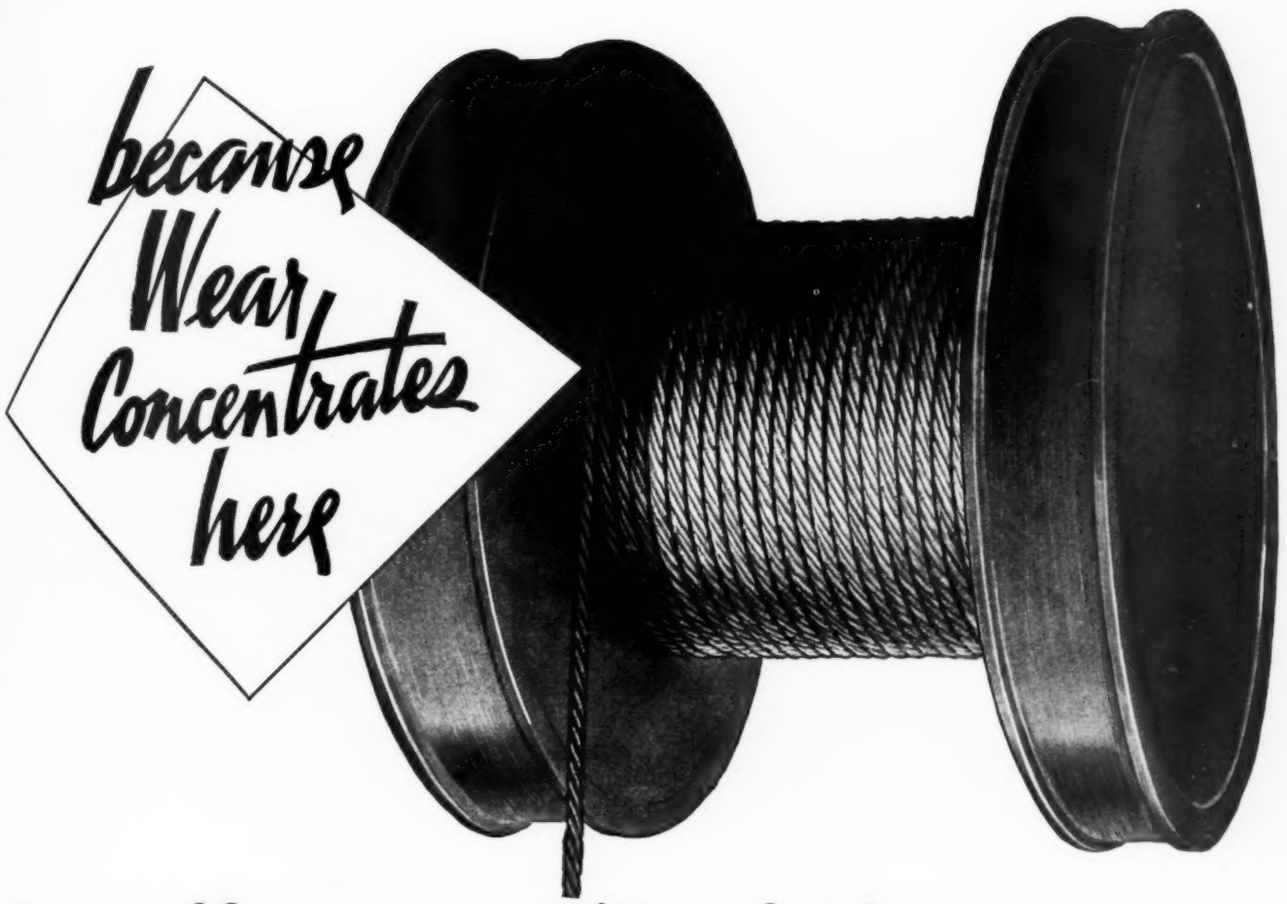
Flow lines should be of a diameter large enough only for the maximum permissible flow of the well, but not so small as to incur a large friction loss.

On small flowing wells the flow line should be free from sharp turns or bends; for a well becomes sensitive to the slightest changes of pressure or flow conditions as it nears the end of its flowing life. Sharp bends in the flow line may cause a premature separation of the oil and gas that will be detrimental to steady flow and may cause the well to head. Likewise, too large a flow line may result in reducing the velocity of flow to such an extent as to cause the oil and gas to separate in the line, which also will be detrimental to the maintenance of a steady flow. Welded connections and bends with a long sweep can be used to great advantage in flow lines.

Nothing has yet been said regarding the length of flow lines. This is a factor that will be governed by the location of the separator or separators and the topography of the field. Avoid having low places in flow lines, particularly at small flowing wells where the rate of flow is not very great. Accumulation of liquid at these low spots promotes the formation of gas pockets at the high spots and may seriously retard or stop entirely the flow of the well.

Extra-heavy pipe or tubing is generally used for the flow lines of high-pressure wells. Where extremely high pressures are encountered, good used drill pipe that has been rigidly inspected and tested may be employed to advantage for the short length of flow line between the casinghead and the flow line manifold outside the derrick. These short lengths of flow line and all the fittings thereon may at times be subjected to the full pressure of the well.

On large high-pressure wells a reasonable limitation of the maximum diameter of flow line should be observed. A flow line, if too large in diameter, will have to be replaced with a line of smaller diameter within a very short time in order to maintain efficient flow. One factor that tends to encourage the installation of flow lines of unnecessarily large diameter is the questionable practice of determining a well's potential (capacity to produce) by arbitrary open-flow methods. With curtailment of production in effect, there are very few oil wells—and this includes the high-pressure wells of large capacity—that require a flow line with a diameter greater than four inches for efficient production.



Cut off an occasional piece from the drum end

Know your Ropes

...This is a helpful hint, how to make wire rope last longer. Subsequent Wickwire Spencer advertisements in this publication will give other dollar saving information. Tell us about your rope problem and we will give you the answer.

Many an otherwise good rope has been scrapped because of worn sections where the changing of layers in winding has worn it out. The *odd layers,* except the first, have a tendency to seat away from the flange but are forced against it. The *even layers* want to hug the flange but are forced away from it. This horizontal travel under load of the first strand of a layer rubs rope to rope and will always wear it. You can change the points of wear, however, by simply cutting off a section, occasionally, from the drum end. Thus by distributing the wear over a greater length you make the rope live longer.

•

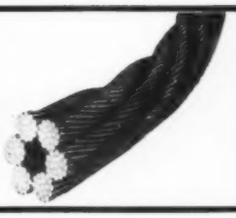
WICKWIRE SPENCER STEEL COMPANY, 41 East 42nd Street, New York City; Branch offices and warehouses: Buffalo, Chicago, Worcester, Tulsa, San Francisco (Pacific Coast Headquarters), Los Angeles, Portland, Seattle. Export Sales Dept., New York City.

WIRE ROPE

by Wickwire Spencer

BOTH...STANDARD LAY AND WISSCOLAY PREFORMED.

Wickwire Spencer manufactures all sizes and types of Wire Rope in standard lays and preformed. Wisscolay preformed wire rope will often solve a wire rope application difficulty. Ask our engineers where and when it should be used. Send for a free WIRE ROPE BOOK. It will prove of great value.



On wells that produce oil having a large volume of gas in solution, and are excessively beaned (that is, have a high differential pressure between the upstream and downstream side of the flow bean), paraffin may have to be guarded against if the flow line is very long and the oil when cool has any tendency to precipitate paraffin. If long flow lines cannot be avoided, then the character of the oil should be given careful study and provisions made if necessary for coping with the paraffin problem in some economical manner.

Only a thorough study of the local conditions will reveal the best procedure to follow in laying out the flow line details.

SEPARATORS. Gas accompanies the oil produced from a flowing well. Means must be provided to separate this gas from the oil before the latter reaches the stock tanks. Oil and gas separators (known also as gas traps) are employed for this purpose. They are installed between the well and the flow or lease tank.

Efficient separation of gas and oil is important in the operation of flowing wells; and it is becoming increasingly so. Although gas may have a high market value as a fuel, it is much more valuable to the producer as a source of energy. How it is handled and the means taken to conserve and utilize it to the best advantage in producing operations, however, are not always given the attention the subject deserves. It is in this phase of producing operations that the oil and gas separator system plays a vital part.

An efficient oil and gas separator system should stabilize the crude, make available without waste or loss of energy all the gas at the working pressure of the separator and regulate the flow of gas from the separator into the gas system without disturbing the flow of the well.

Separators in most common use are those of the upright cylindrical type. They range in size from three to five feet in diameter and from five to 15 ft. in height. There are several different makes but almost all have special baffles or other devices to accelerate the separation of the gas and oil. The average working pressures employed range from a few inches of vacuum to 500 lb. per square inch. Many separators on flowing wells are operated at pressures as high as 700 pounds. Based on the working pressures, all the different types of separators may be classified under three heads: low-pressure separators, intermediate-pressure separators and high-pressure separators. The low-pressure separators operate at any working pressure between a vacuum and a pressure of 50 lb. per sq. in.; intermediate-pressure separators between 50 and 150 lb.; and high-pressure separators at any working pressure above 150 pounds. Either of these three types of traps may be used singly on a well or in any combination with the other two and in parallel or series, depending upon whether single-stage, double-stage, triple-stage or a higher stage gas and oil separation system is adopted. Later on in this article, when we come to consider separator systems, the conditions under which different separator combinations may be used will be discussed.

Modern gas traps are equipped with automatic liquid level controllers. Perhaps the most widely used of these is the float type of control.[26] There are two classes of liquid float controls, the internal float and the external or float cage type. Both classes are widely used on well separators.

Sometimes conditions arise in the field that necessitate a departure from standard practice. During the development of the Oklahoma City field, sand in the oil became a source of trouble in separators and special provisions had to be made to counteract it.[27] Among other things an extra separator for handling the sand was installed at many of the wells. A diaphragm control that operates automatically by the liquid pressure in the separator was also devised and put into successful use. Separators may be equipped with dual liquid level controls as an extra safeguard where extremely severe conditions in high-pressure wells are encountered. The diaphragm control may be employed to advantage along with a float control where paraffin deposits interfere with the operation of the separator. These controls regulate the flow of oil out of the trap. The oil and gas direct from the well come in at or near the top of the trap and as the oil passes down through the baffles to the bottom, the gas is released, rises to the top of the trap and passes through a regulator and out into the gas gathering lines. The regulator, which is set to the working pressure of the trap, controls the gas outlet. The trap is usually equipped with safety release valves. One of these is a pop valve and the other a dead weight type of release valve. The dead weight valve is usually set in a vent line that carries the gas off to the atmosphere through a riser (20 to 30 ft.) several hundred feet away from the well. The vent line is usually from four to six inches in diameter.

Many factors affect the capacity of separators. Estimating the capacity of separators is difficult, both because of the many variable factors that enter and the paucity of the available data. When several separators are used on one installation the estimation of capacities is more involved. Results from a series of tests in which the gas-oil ratio was fairly constant indicate that the "free gas" capacity of a separator of normal height is related to its cross-sectional area. By "free gas" capacity is meant the volume of gas free from oil that the separator will handle and does not include the gas in solution in the oil in the separator at the working pressure. March,[28] who reports these results, gives for oil and gas separators of different diameters, the approximate variation in capacity at different working pressures. At an operating pressure of 100 lb. per sq. in. a separator of 24-in. diameter has an approximate daily "free gas" capacity of 4 million cu. ft.; of 30-in. diameter, 8¾ million cu. ft.; of 42-in. diameter, 8¾ million cu. ft., and of 48-in. diameter, 13 million cu. ft. daily. These are the average results of a series of tests during which the average gas-oil ratio was about 4000 cu. ft. per barrel. The gas-oil ratio also affects the capacity of separators. As given by March,[28] the approximate variation in the "free gas" capacity of oil and gas separators is somewhat as follows: Assuming the "free gas" capacity at a gas-oil ratio of 4000 cu. ft. per bbl. is 100 per cent, at a gas-oil ratio of 9250 cu. ft. it would be 125 per cent; at 22,000 cu. ft. 150 per cent; and at 32,000 cu. ft. approximately 155 per cent.

Many factors have to be taken into consideration in order to decide on the separator system. First of all, there is the well itself, its productivity, flowing characteristics, gravity of the oil, and amount of gas in solution. This information will be gathered from field and laboratory tests; second, how the gas is to be utilized or disposed of after it leaves the separator. This information may have to be obtained by investigating the economic factors involved; and third, the probable life of the well and the field as a whole. With this information, equipment for the separator system may be chosen in accordance with the trend production is likely to follow. If large capacity equipment is required at the start, it may be installed in units that could later be taken out as the field declined and moved to a new location, thus effecting substantial operating economies without any sacrifice in efficiency.

Whether or not single-stage, double-stage or triple-stage separation of the oil and gas is adopted will be governed by the well pressure and how the gas from the separator is to be used. If the operating pressure of the well is high it may be necessary to separate the oil and gas in two stages. The investment in separation equipment is likely to be lower on

high-pressure separation systems than on low-pressure separation systems. For example, assume two-stage separation, a well pressure of 325 lb. and that the high-stage separation takes place at 300 lb. pressure. A large proportion of the gas released at the high-pressure separator is probably free gas and dry, so little would be gained by separating it at low pressure. By virtue of the high-pressure, separation has taken place in a smaller space than might be possible were the pressure lower. In addition, less low-pressure separator capacity is required since only the gas that remained in solution in the oil at 300 lb. has to be separated from the oil. The two-fold advantage is obvious.

One or more separators may be used in each stage of separation and these are connected in parallel. The battery of separators in any one stage, however, is connected up in series with the batteries of separators in the other stages. The number used in each stage will depend upon how the gas from the separators in each stage is used. In a triple-stage oil and gas separation system the gas from the high pressure separator may be used for flowing wells; the gas from the intermediate-pressure system sent to a compressor plant, there to be boosted to a higher pressure, have the gasoline extracted, and then used for flowing wells; and the gas from the low-pressure separator sent to a casinghead plant to be stripped of its gasoline and then sold as natural gas. The requirements of gas from any one of the three stages of separation may be subject to wide fluctuations. These requirements and their fluctuations will be important factors governing the design, the number of stages, and the capacity of the separator system.

Another important item is the location of the separators with respect to the well and the lease tanks. As in all other matters relating to separator installations, practice in regard to where and how the traps are set up in the field varies widely. In high-pressure fields where multiple-stage separation of oil and gas is employed, two important governing factors are the well-spacing and the topography. In the Oklahoma City field, for example, well-spacing is a dominating factor affecting the layout and location of the oil and gas separators. In Kettlemen Hills field, California, on the other hand, the topography is a dominating factor influencing the layout and location of the oil and gas separators. Three systems of laying out separator equipment and flow lines are recognized in this field; (1) the separators and flow tanks are set close by the well and comprise a complete unit; or (2) the separators and lease tanks are set up adjacent to one another at some advantageous point irrespective of the location of the well; or (3) the high-pressure separator is set at the well and the rest of the separators and the tanks set at some advantageous point irrespective of the well.[29] The factors that govern the setting of separators in the Kettleman Hills field are, however, considered of little importance in the Oklahoma City field. In the latter field, the sand produced with the oil and gas and the proximity of the field to the city have influenced the layout of the oil and gas separator system at the wells.

It is good practice to set the high-pressure separator some distance away from the well in high-pressure areas. They should be set reasonably near the lease tanks, however, so the man gauging the tanks may be able to keep his eye on the operation of the separator.

Low-pressure traps are set at the well and elevated sufficiently high (15 ft. to 30 ft.) so the oil will flow from the separator to the stock tank by gravity. This is now considered good practice at flowing wells.

An oil and gas separator at each flowing well is not always necessary. If the wells are small and are allowed to produce only a small fraction of their production, and that in a few hours, it may be sound economical practice to set one separator to care for several wells. Where that plan is adopted, the separator is set up at some point convenient to all the wells, and usually adjacent to the lease tanks. All the flow lines are connected into a manifold by means of which only one well at a time is flowed through the separator. This plan is used on a number of small flowing wells in the East Texas field.

An example of good practice at small flowing wells is the use of vapor-tight flow tanks to prevent evaporation and provide a means for recovering the rich vapors from the crude that otherwise might be lost. Only a few inches of vacuum is carried on the vapor-tight tank, which also serves as a lease flow tank. The top of the tank is connected into the vapor recovery system of a near-by casinghead gasoline plant.

Practices involving the separation of oil and gas are undergoing rapid changes. Operations pertaining to the producing of the well, the running of the gas-lift plant and the casinghead plant, all are interrelated in this phase of oil production. So closely do these three operations come to overlapping one another that a change made by one usually affects the operations of the other two.

Oil and gas separation may also be considered from another angle, that of controlling the gravity and preparing the crude for pipe line requirements. An efficient solution has been suggested; that is, all gas should be removed on the lease, where it can be used to greatest advantage; so combine dehydration, degasification, stripping and stabilization of the crude in one operation on the lease, immediately the oil comes from the well.[30]

Low first cost and minimum operating expense must be kept uppermost in the design and installation of oil and gas separator systems. Competent engineers who have gone deeply into this problem lay stress on the importance of adopting oil and gas separation equipment that will fit into the production program, not for a year or two, but throughout the life of the well or field.

●

QUESTIONS

1. Explain the conditions under which too large a flow line could be a detriment.
2. What determines the capacity of an oil and gas separator?
3. What is the function of an efficient oil and gas separator system?
4. What effect on the capacity of an oil and gas separator has:
   (a) A decrease of working pressure?
   (b) An increase of gas-oil ratio?

●

REFERENCES

[26]"Application of the Internal Float Liquid Level Controller," by Kenneth R. D. Wolfe, *The Petroleum Engineer*, Midyear issue, 1932.

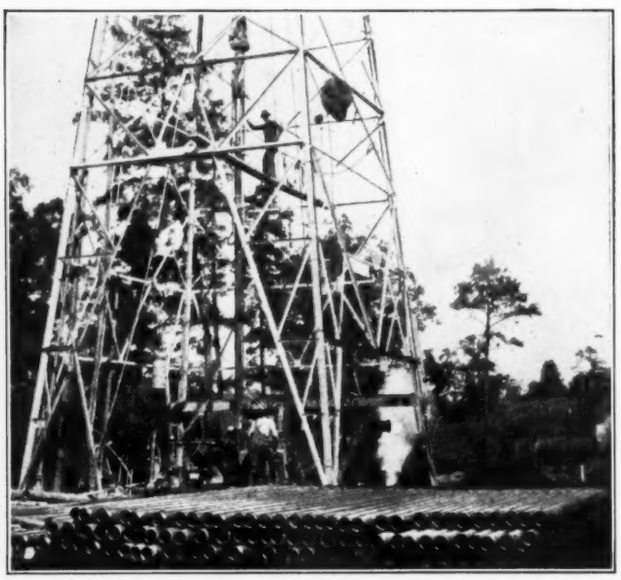
[27]"Safety Devices Protect Separators from Excessive Damage," *The Petroleum Engineer*, July, 1932.

[28]"Installation of Oil and Gas Separators and Vapor Systems in California," by R. A. March, A.P.I. Production Bull. 208, December, 1931.

[29]"Production Practices at Kettlemen Hills," by A. F. Wilson and George O. Suman, A.P.I. Production Bull. 208, December, 1931.

[30]"Controlling Gravity and Preparing Crude for Pipe Line Requirements," by Charles P. Buck, *The Petroleum Engineer*, April, 1932.

Evidence of Chester Popularity



"Chester" casing has been famous in the oil fields for over a quarter of a century.

Its reliability under severe drilling conditions has made it so.

"Chester" Line Pipe also has enjoyed popularity all over the world. Joints that never leak.

Chester also makes "Wrought Iron" pipe — manufactured from genuine old-fashioned hand-puddled muck bar made in our own mills from 100% pig iron.

SOUTH CHESTER TUBE COMPANY, Chester, Pa.

District Sales Managers

W. E. Gibson: 801 Columbia Bank Bldg., Pittsburgh, Pa.
H. A. Morse: 30 Church St., New York, N. Y.
J. P. Cooney: 715-716 A. G. Bartlett Bldg., Los Angeles, Calif.
J. P. Steele: 217 Petroleum Bldg., Ft. Worth, Texas.

District Offices

J. D. Swartz: 1231 S. Evanston St., Tulsa, Oklahoma.
E. L. Moseley: 2218 Mills St., Houston, Texas.
Burt S. Shafer, Southwest Representative: 4313 Fairfax Ave., Dallas, Texas, or 217 Petroleum Bldg., Ft. Worth, Texas

District Warehouses

Houston, Texas; Thenard, Calif.; San Francisco, Calif.

Distributors

United Pipe & Supply Co., Charleston, Danville, West Hamlin, W. Va.; Paintsville, Ashland, Allen, Prestonburg, Ky.

Prichard Supply Co., Mannington, W. Va.; Mather and Waynesburg, Pa.

LeValley, McLeod, Kinkaid Co., Inc., Elmira and Olean, N. Y.

Kane Supply Company, Kane, Lawrenceville, Brookville, Pa.
Bovaird & Co., Bradford, Pa.
Pelican Well Tool & Supply Co., Shreveport, La., Kilgore, Texas.
Great Northern Tool & Supply Co., Billings and Kevin, Mont., Kemmerer and Cody, Wyo.
Star Drilling Machine Co., 550 Clinton St., Portland, Ore., and Akron, Ohio.

Stephen H. McCabe, 508—4th St., San Francisco, Calif.

Barde Steel Company, Seattle, Wash., and Portland, Ore.

Louisiana Supply Co., Sulphur, La., and Brimstone, La.

Dunigan Tool and Supply Co., Main office, Breckenridge, Texas. Branch stores, Willow Springs, Pampa, Turnertown, and McCamey, Texas, and Hobbs, N. M.

CHESTER

STEEL CASING AND LINE PIPE

Elements of Applied Petroleum Refining

By W. L. NELSON
Professor of Petroleum Refining,
University of Tulsa

Article V

FLOW DIAGRAMS, OPERATING DATA AND DISCUSSION (Continued)

TYPICAL FLOW DIAGRAMS AND OPERATING DATA (Continued)

NATURAL GASOLINE. In the past the compression process of recovering natural gasoline from natural gas has been widely used. When a gas mixture is compressed the partial pressure that is exerted by each component is increased, and if the pressure is increased enough the partial pressure will be equal to the vapor pressure of the component and it will condense. From another angle the phenomenon can be explained by saying that the dew-point is increased as the pressure is increased. Today, compression plants are seldom used alone, but the gas for absorption plants is often compressed so that the modern absorption process of natural gasoline recovery is really a combined process of compression and absorption. The adsorption process by which natural gasoline was absorbed by charcoal, attracted much attention shortly after the world war, but it has almost been abandoned.

General Process. The general process of recovering natural gasoline will be illustrated by a flow chart, which will appear with next month's article. The wet gas passes up through the absorber column and absorption oil flows down the column. The rich oil passes through heat exchangers, then through a steam heater and into the stripping column. Both the absorption and the stripping columns may be of the same construction as the bubble towers used in distillation. Heat is supplied to the stripping column by means of a reboiler heated by steam. In the stripping still the gasoline is stripped from the rich oil by means of process steam and the lean oil passes back through the heat exchanger system and coolers to the absorption tower. The wild or unstable gasoline is pumped into the rectifier or stabilizer in which the high vapor pressure components, such as propane and sometimes butane, are removed. The stabilizer is similar in principle to the distillation systems presented in previous articles except that much of the heat is added at the bottom of the tower by means of a reboiler and a high pressure is maintained in order to condense propane as reflux for the top of the column.

Systems similar to the above are also used for the recovery of the gases that are produced in the refinery. Crude stills all produce some gas, and large amounts of gas are produced during cracking. These gases, along with the gases from storage tanks, etc., are handled together in the absorption system. These gases usually contain large quantities of gasoline.

Pressure distillate is condensed at pressures of 15 to 200 lb. per sq. in., depending upon the type of cracking process that is employed, and hence it contains light hydrocarbons. Pressure distillate from a gas separator at 200 lb. per sq. in. is similar to wild natural gasoline.

Table 3 shows the analysis of a pressure distillate and several gasolines. Pressure distillates are frequently stabilized along with the wild natural gasoline from the gasoline plant.

TABLE 3
Analysis Per Cent by Volume (Gas)

Material	A. P. I.	V. P.	CH_4 and gas	C_2H_6	C_3H_8 and C_3H_6	C_4H_{10} and iC_4H_{10}	C_5H_{12} and iC_5H_{12}	C_6H_{14} and heavier
1. Raw gasoline (Low-press. absorber)	.....	.....	.....	1.82	12.72	32.6	30.1	22.76
2. Raw gasoline (High-press. absorber)	92.2	50	.04	1.78	16.03	35.76	17.78	28.61
3. Pressure distillate (175-lb. separator)	59.0	.....	.09	3.08	6.71	8.74	8.36	73.02
4. Stable gasoline	78.7	17.2	.....	.....	.....	17.86	30.91	51.23
5. Commercial butane	.581*	65.0	.....	.....	0.09	3.41	96.5	.....
6. Bottle gas	.....	.....	.....	2.0	98.0	.....	.....	.....

*Sp. gr. 60/60

The Absorber. Absorbers normally operate at a pressure of 35 to 85 lb. per sq. in., but during the last two years many high-pressure (300-500 lb. per sq. in.) absorbers have been built. In general, it is not economical to compress a gas to these high pressures so that a high pressure is not generally used unless the gas is available from the field at a high pressure. Absorbers operate at atmospheric temperatures, except that a slight increase in temperature is noted if a relatively large amount of gasoline is absorbed. This condition arises if the gas is very rich or a very high pressure is used. Normally about 16 bubble plates are used in an absorber.

The factors that affect the amount of absorption oil that is required are:

(1) Number of plates—More plates require less oil.
(2) Composition of gas—Rich gases require more oil.
(3) Properties of absorption oil—A low molecular weight well-stripped oil is desirable.
(4) Temperature—Higher temperatures require more oil.
(5) Hydrocarbons to be recovered — Low vapor pressure hydrocarbons are recovered easily, but large amounts of oil are required to recover gases such as propane.
(6) Pressure—High pressures require less oil.

The Stripping Still. Stripping is the reverse of absorption. In the absorber the oil absorbs part of the gas, whereas in the stripper the gas (steam) removes the gasoline from the oil. While low temperatures are advantageous in absorption, high temperatures are advantageous for stripping. Likewise, the light hydrocarbons are most easily removed during stripping and high molecular weights (low vapor pressure)

absorption oils are best. The selection of the absorption oil depends upon the economics of the combined absorption and stripping operations. Since the stripping is usually the simpler operation, relatively light oils are generally used. Absorption oils usually have an A.P.I. gravity of 34 to 38.

In large plants the rich absorption oil is sometimes heated in a pipestill. Temperatures of 300 deg. fahr. are common. The reboiler may be heated with hot oil if the gasoline plant is situated in a refinery.

The Stabilizer. The stabilizing of natural gasoline is perhaps the most exact fractionation that is practiced in the oil industry. At one time the wild gasoline was stabilized by weathering. In this process the gasoline was allowed to stand in tanks at atmospheric pressure or at a slight pressure. The light materials vaporized, but they carried with them a large amount of the valuable gasoline. Thirty plates are often used in stabilizer columns in order to get an exact separation of the gasoline from the lighter hydrocarbons. One per cent of propane increases the vapor pressure of common natural gasolines about one pound. If the vapor pressure of a gasoline is high, the gasoline will tend to vaporize in the feed system and cause vapor-lock.

HEAT EXCHANGE. The amount of heat that should be recovered from the hot products of a processing plant is an economic consideration. Among the factors that are of greatest importance are:

(1) The temperature of the hot stock. A high temperature gives a high rate of heat transfer and hence a smaller and less expensive exchanger is required. In other words, the stocks that are at a high temperature are the most desirable. At the same time, too large a temperature difference should not exist between the two fluids or the exchanger will tend to develop leaks.

(2) The quantity of the stocks. Considering the amount of heat that is transferred, small exchangers are more expensive than large exchangers.

(3) In general, stocks that contain suspended solid matter, such as carbon, lime, sand, etc., are not suitable for heat exchange. Exchangers can be built that do not become plugged when such stocks are used, but very often they give trouble. Perhaps the best type of exchanger for handling stocks that contain solids is a home-made exchanger with a tank for a shell and a coil of welded pipe for the tubes.

Although all exchangers must be cleaned, certain conditions require that the exchanger be cleaned very often. With certain hard waters and some corrosive stocks, the exchangers or coolers must be cleaned several times a week or blown-out with steam each day. Under such conditions the operating expense and expense for upkeep is high and hence more heat must be saved in order to effect an economy.

(4) The corrosive action of the stock. Exchangers for corrosive stocks must either be replaced after a short time or be built of special corrosion resistant materials that are expensive. At the same time the rate of heat transfer is lower because of the scale that is produced.

(5) The pressure at which the stocks are available. If the stock is at a high pressure it can be passed through the exchanger at a high velocity and a higher transfer rate will be possible. Stocks that are withdrawn from the side of a fractionating column are not usually pumped, and hence little can be done about the pressure at which these stocks are available.

(6) Any factors that tend to increase the transfer rate. High transfer rates are obtained at high velocities, with low viscosity oils, and if condensation occurs. Low rates are obtained with vapors (not condensing) and if the exchanger is dirty or corroded. Condensing exchangers (often called vapor heat exchangers) are particularly suited to heat exchange because a relatively large amount of heat is removed for each degree of temperature that the vapor is cooled. Thus a larger temperature difference is available.

All these factors should be considered in determining the amount of heat exchange that is feasible. If the exchanger does not pay for itself (by paper figures) by the heat that it saves in two years the installation is not considered as economical. Some refiners demand that an exchanger must pay for itself in less time. One factor is frequently overlooked when considering the economies of heat exchange. If the stock is taken from the heat exchangers into another heater as in Figs. 13 and 14 (the titles are reversed) in Article IV, the efficiency of the pipestill decreases as the charge stock is heated to higher temperatures. This results because the stack temperature of the gases from the furnace must be maintained at a higher temperature and hence more heat is carried away in the stack gases.

The charge stock may be heated in other plants than the one in which the stock is distilled. Fig. 14 (title should be "Topping Plant") in Article IV is an example. The charge stock is heated by exchangers in the topping plant and then goes to exchangers in the vacuum plant. Since the temperatures are much higher in the vacuum plant the stock can be heated to a higher temperature than is possible in the topping plant. Stocks are often sent through exchangers in a cracking plant for the same reason. It is sometimes possible with this sort of an arrangement to reach a temperature of 650 deg. fahr. and thus eliminate the topping pipestill altogether.

While elaborate heat exchange systems appear well, they are not without disadvantages. The interdependency of several plants upon one another is a serious complication from the operating standpoint. Thus if one plant must be shut down, the other plant or plants must also be shut down or operated in a crippled condition.

Although heat exchangers are now widely used, they are a source of much trouble in some refineries. In some cases this is due to the corrosive properties of the oil that is processed or to the sediment that it contains, but more often it is due to an improper understanding of the particular usefulness of each type of exchanger and to carelessness in the upkeep of the exchanger systems. Exchangers must be cleaned frequently if they are to function efficiently and if corrosion is to be avoided. Facilities should be provided, at the time the exchangers are installed, for cleaning them.

QUESTIONS

1. List four factors that affect the amount of oil required for absorption.
2. High-pressure absorbers are best from many standpoints. Why are they not more generally used?
3. Why should the vapor pressure of gasolines be low?
4. List four important factors that should be considered in determining the economy of a proposed installation of exchangers.
5. Why is the stock usually sent through the vapor-condenser exchangers first and through the bottoms exchanger just before entering the pipestill?

REFERENCES

1. Burdick, "Kettleman Gasoline Plant Unique." The Oil and Gas Journal, April 9, 1931.
2. Reid, "Degasification of Pressure Plant Products." The Refiner, p. 97, July, 1930.
3. Leech, "Adaptation of the Fractionating Still to Absorption Plant Stabilization." The Petroleum Engineer, p. 22, May, 1933.
4. Brown and Souders, "Design Calculations for Vapor Recovery and Rectifying Units." The Refiner, p. 376, June, 1932.

Vocational Refinery Mathematics

Stills and Fractionating Equipment

Heat Balance, Vapor Velocities and Other Calculations

By
P. ALBERT WASHER

Article 5

PROBLEMS involving calculations have stirred more interest than all others, pumps not excepted. This subject takes in much in the field of chemical engineering. However, the problems are so simplified that the refinery worker can grasp them without much difficulty, especially if he has become familiar with all the data presented in preceding articles of this series.

The principal factors that control the rate of distillation, in other than tube stills, are:

1. The evaporating surface.
2. The heating surface.
3. The area of the vapor outlet.

The evaporating surface, for the usual type of horizontal cylindrical still, may be taken as two-thirds of the diameter multiplied by the length, when the still is operated on the batch principle.

The heating surface must, of course, be ample to transfer sufficient heat to effect distillation. In case of continuous stills, the full half circumference is often fired. Records of such stills show that 2.5 gal. of distillate per hr./sq. ft. of heating surface may be depended upon.

The area of the vapor pipe must be sufficient to permit free and unrestricted passage of the oil vapors and free steam (if used) to the condensers, at a rate sufficiently high to accommodate the full still capacity, as determined by the preceding factors.

A standard of not less than 0.17 sq. in. for each gal. of overhead distillate per hr. is suggested.

Before calculating the still problems it is necessary to know how to work the following empirical equations:

HEAT CONTENT OF PETROLEUM OILS

(64) $H_l = \sqrt{d}\ (3.235t \times 0.001875\ t^2 - 105.5)$

where:

H_l = Heat content of liquid in B.t.u. per gallon
d = Sp. gr. at 60/60
t = Temp. in deg. fahrenheit

(Vapors)

(65) $H_v = \sqrt{d}\ (3.225t + 0.001875t^2 - 105.5) + 925 - .75t.$

Example:

Given: Specific gravity, d = 0.9340, t = 100
Find, heat content of liquid in B.t.u. per gallon

Solution:

$$H_l = \sqrt{.9340}\ (\overline{3.235 \times 100} + \overline{001875 \times 10000} - 105.5)$$
$$= .965\ (3.235 + 18.75 - 105.5)$$
$$= .965 \times 237 = 229 \text{ B.t.u./gallon.}$$

The ambition of most workers, especially the process men, is to solve a typical problem on the stills. To the men working on the stills the term "absolute pressure" is quite familiar but it is not always clearly understood by the worker at the treater or in the gauging division, etc. Absolute pressure is simply gauge pressure plus atmospheric pressure and in the refinery is usually given in inches of mercury (1 in. Hg = 25 mm.). The higher the absolute pressure the lower is the vacuum and the lower the absolute pressure the higher is the vacuum. To eliminate confusion of these terms the following illustration is of considerable help:

(Assume data: Atmospheric pressure as 30.00 in. "Hg.")

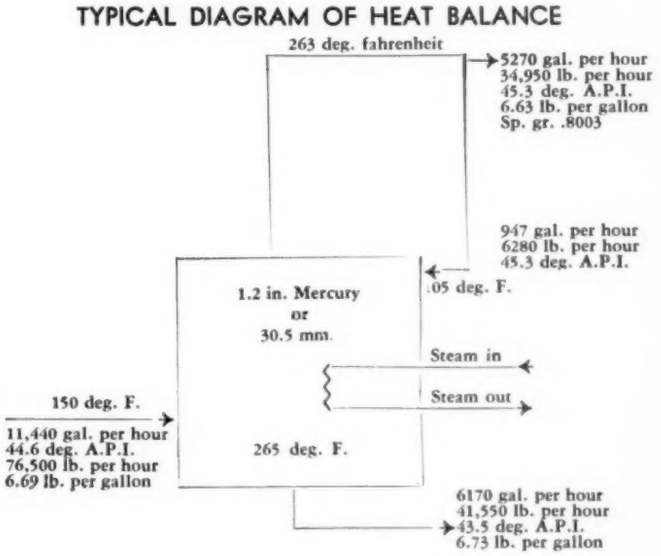
	Column 1 Absolute Press.		*Column* 2 Atmospheric Press.		*Column* 3 Gauge Reading
a.	30.00	is equal to	30.00	plus	0.00
b.	42.00	is equal to	30.00	plus	12.00 (press.)
c.	34.00	is equal to	30.00	plus	4.00 (press.)
d.	20.00	is equal to	30.00	plus	—10.00 (vac.)
e.	1.00	is equal to	30.00	plus	—29.00 (vac.)
f.	0.00	is equal to	30.00	plus	—30.00 (vac.)

That is, if we had an absolute pressure of "0" on a vacuum still (best ejectors good for about 3 mm.) we would have a perfect vacuum; if the absolute pressure gauge read 30.00 in. it would indicate that the still was simply under atmospheric pressure. Vacuum stills are usually equipped with absolute pressure gauges and the topman, therefore, reads column 1 direct. For figuring problems in steam, etc., a Bourdon pressure gauge is used and gives (in lb. per sq. in.) column 3 (a, b, c). The absolute pressure is obtained as shown but substituting the corrected barometric reading taken at the particular time and using same units as Hg.; lb./sq. in., etc. A compound gauge is used where the system is partly under pressure and partly under vacuum as long suction lines, etc. (Piezometer method used also). Bearing these facts in mind, we are ready to proceed with our problem on the still. A diagram of the case should *always* be made as shown hereunder.

Given:

1. Top vapor temp. 263 deg. fahrenheit.
2. Absolute still press. 1.2 in. Hg. or 30.5 mm.
3. Molecular weight of overhead, 176.
4. A.P.I. grav. 45.3; Sp. gr. at 60, 0.8003; weight, 6.663 pounds.
5. Latent heat, L_v, 126.
6. Charge, 11,440 gal. per hour.
7. Bottoms, 6,170 gal. per hour.
8. Stream, 34,950 gal. per hour.
9. Wash, 6,280 gal. per hour.

TYPICAL DIAGRAM OF HEAT BALANCE



NO SQUARE PEGS in ROUND HOLES

●

Having pioneered in the development of piston rings of many designs and many types, American Hammered's recommendations are made only to fit the one specific job.

ENGINEERS of American Hammered have not been content with the development of any one type of single-piece power or oil-control ring. Neither have they confined their activities to the development of multiple-piece rings. It is always the special requirements of *every* individual job that interest them—and the designing of piston rings for *every* kind of service.

Piston-ring development has been carried forward by American Hammered in step with the development of modern engines of all kinds. From this varied and vast experience, both in the field and in the laboratory, the engineers of American Hammered will be glad to make an accurate piston-ring recommendation for you—one entirely unbiased, based only on most efficient performance. Call upon the branch office nearest you. The American Hammered Piston Ring Company, Baltimore, Maryland.

BRANCH OFFICES

Tulsa, Okla.	404 East Second Street
Seminole, Okla.	107 First Street
Fort Worth, Tex.	2603 Azle Avenue
Houston, Tex.	4605 Polk Street
Long Beach, Calif.	501 Pico Street
Winfield	Kansas

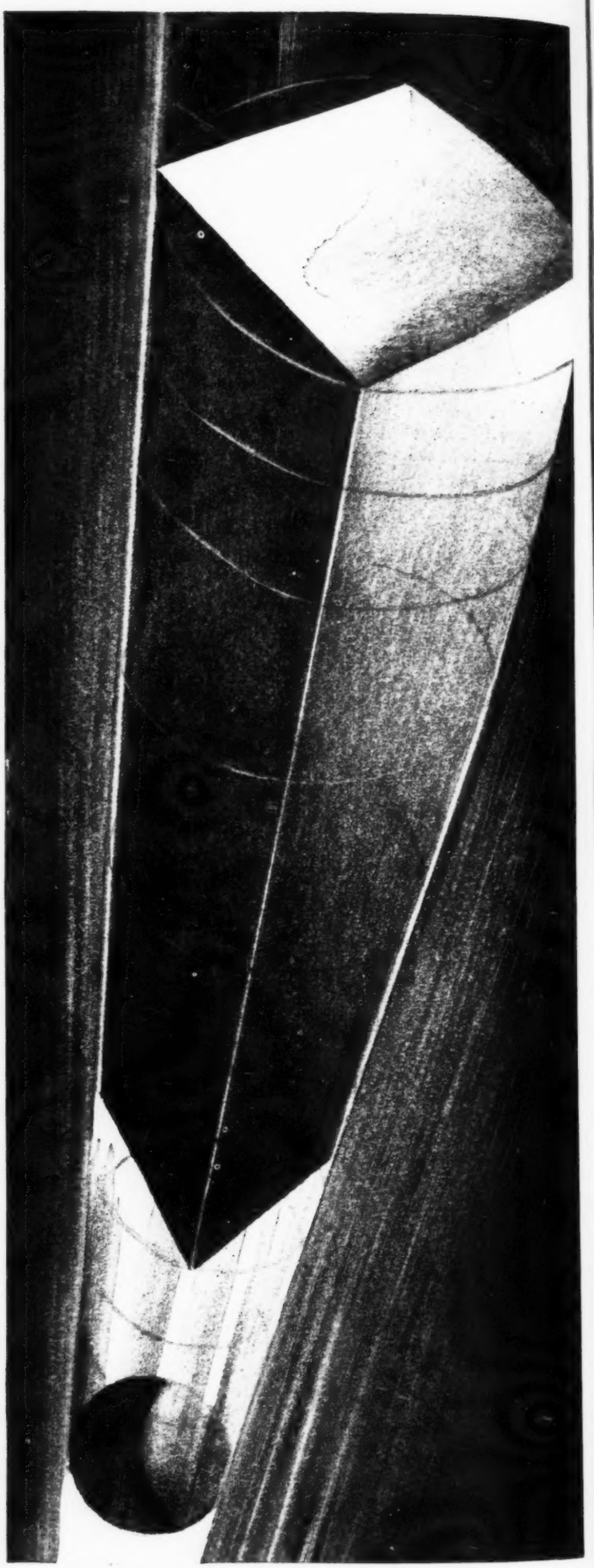
SEE OUR EXHIBIT AT THE OIL SHOWS
Houston, April 16th to 21st
Tulsa, May 12th to 19th

NRA MEMBER U.S. WE DO OUR PART

American Hammered

ENERGIZED PISTON RINGS

IN EVERY SIZE . . . OF EVERY TYPE
FOR EVERY PURPOSE



The data above are all obtained from instruments or charts as outlined in the former articles, except for the latent heat and molecular weight. The latent heat is obtained by using formula (14), thus:

$$L_v = 1/d\ (110.9 - .09t)$$
$$L_v = 1/.80003\ (110 - .09 \times 105) = 126.$$

The molecular weight is obtained by the Hilderbrand method as shown on the chart, Fig. 5. That is, the log. vapor pressure is plotted against latent heat, L_v, and from the proper curve the molecular weight is selected. To maintain simplicity throughout the course, assistance may be necessary in selecting the proper molecular weight, for the term "mol" at first, may cause the average man to fear the difficulty of the subject. However, after a thorough drilling of the preliminary data and the following illustration he gains confidence in his ability to grasp this phase of refinery work.

Thus:

$$\frac{\text{lb./hr.}}{\text{Mol. wt.}} = \text{Mols./hr.}$$

We are now ready for a problem in heat balance.

Example: Data as already given in still problem (see heat-balance diagram).

HEAT BALANCE ABOVE TOP VAPORS

Charge = 11,440 (780 — 385) =	4,576,000 B.t.u./hr.
Bottoms = 6,170 (800 — 795) =	30,000 B.t.u./hr.
Stream = 34,950 × 126 =	4,400,000 B.t.u./hr.
Wash, sensible 947 (780 — 230) =	521,000 B.t.u./hr.
latent 6280 × 126 =	790,000 B.t.u./hr.
Heat input from coil, =	10,317,000 B.t.u./hr.

The figures in parentheses are all obtained by the simple application of formulae (64) and (65) on heat content. To obtain the heat flow Q/Φ, as given in article 4 (p. 54, February issue, *The Petroleum Engineer*) under oil to oil heat exchanger, we use formula (64), thus:

Given:

Oil out -	374 deg. fahr.	Oil in -	481 deg. fahr.
Oil in -	119 deg. fahr.	Oil out -	305 deg. fahr.
Gr. A.P.I. - - -	40.0	Gal. per hr. - -	7800

7800 (959 — 278) = 5,310,000 B.t.u. per hour.

It is very often necessary to determine the amount of steam used when there are no meters. This is quite easy after having obtained the data above.

Thus:

$$\frac{10{,}317{,}000}{(1225 - 315)} = 11{,}320 \text{ lb./hr.}$$

Formulae of considerable interest pertaining to the fractionating equipment, etc., are given below:

VAPOR VELOCITY

$$(66)\quad V = \frac{\text{lb. dist.} + \text{knockback}}{M} \times \frac{359}{3600} \times \frac{T + 460}{492} \times \frac{14.7}{14.7 + D} = \text{cu. ft./sec.}$$

where:

V = Vapor vel. in cu. ft. per second
T = Still temperature
P = Still press. Hg. absolute
M = Mol. wt. (Av. wt. of liquid and vapor).

In designing columns the vapor velocities must be kept within reasonable limits to avoid undue friction; that is, vapor passages must be adequate. There must, of course, be sufficient pressure to overcome the liquid head on the plate and the friction through the vapor passages into the liquid. If the vapor velocity through the tower becomes too great splashing will reach a point where the liquid is carried almost bodily into the plate above and from the top plate into the condenser. This effect is what limits the capacity of a column.

SUPERFICIAL VELOCITY

$$(67)\quad V_s = \frac{V}{A}$$

where:

V_s = Superficial velocity in ft. per second
V = Actual vel. (see above)
A = Area of cross section = $\frac{\pi d^2}{4}$

BELL CAP FORMULA

$$(68)\quad N = \sqrt{\frac{V\,W}{S}} \times C$$

where:

N = No. of bell caps per plate
S = Sp. gr. at av. tower conditions
W = lb./hour
V = Velocity
C = Constant, depending on size of caps.

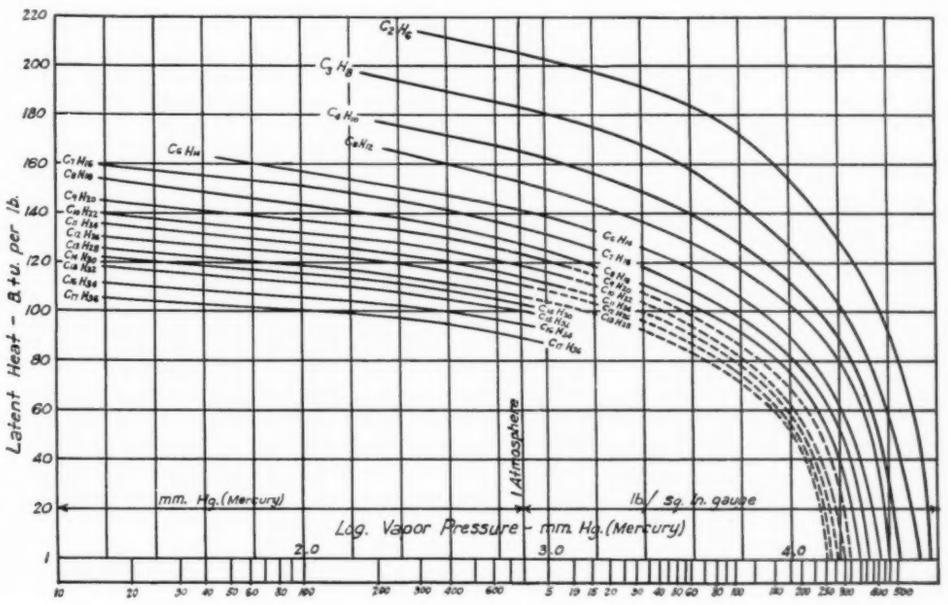


Fig. 5. — Heat of vaporization vs. log. vapor pressure (Hildebrand's Method)

Other Formulae

Calculation of Knockback. (Depending on conditions). Knockback from cooling oil:

(69) $$K_b = \frac{W\ (T_1 - T_2)\ S}{L_v \times M}$$

in which:

K_b = Knockback from cooling oil, lb./hr.
T_1 = Temp. of oil out
T_2 = Temp. of oil in.
S = Sp. heat
M = Mol. wt.
L_v = Latent heat
W = Lb./hr. of cooling oil.

(70) Knockback from wash:

$$K_{bw} = \frac{W_a\ (T_v - T_w)\ S + L_v}{L_v \times M}$$

K_{bw} = Knockback from wash, in lb./hr.
T_v = Top vapor temp. deg. fahr.
T_w = Wash temp. in deg. fahr.
S = Sp. heat
L_v = Latent heat
M = Mol. wt.
W_a = Wash in lb./hr.

(71) Reflux ratio:

$$R.R. = -\frac{O}{P}$$

where:

R.R. = Reflux ratio
O = Overflow or knockback
P = Product.

It should be borne in mind that if the amount of reflux for a given product be increased in order that the number of plates in the column may be decreased, the heat consumption of the operation is proportionally increased, and the cross section of the column must be enlarged to accommodate the greater volume that must rise through it.

Another point to bear in mind is that adequate overflow pipes for the reflux must be provided, especially in those cases where the vapor quantity is small compared with the overflow. The capacity of these pipes is limited by the amount of liquid that can enter them, since this flows in under low head. The upper edge of the pipe acts as a weir, and the flow can be calculated by the Francis formula, (25), altered as follows:

$$V = 3.33\ L\ (H)^{3/2}$$

where:

V = Cu. ft. per sec. discharged by each overflow pipe.
L = Perimeter of overflow pipe in feet
H = Head on overflow pipe in ft. or maximum depth of liquid above edge of overflow pipe.

(72) $$C_u = \frac{V_s}{V_a}$$

in which:

C_u = Capacity tower utilized in per cent
V_s = Superficial tower velocity in ft. per second
V_a = Allowable disengaging velocity from screen plates in ft. per second.

Example of formulae given above:
Given: Data under the main problem.
Required: R.R., Velocities, etc.

Solution:

1. Reflux = $\frac{(521{,}000 + 790{,}000)}{126} = 10{,}410$ lb./hr.
2. R.R. = $\frac{10{,}410}{34{,}950} = 0.30$ to 1.0.
3. Mols. stream = $\frac{34{,}950}{176} = 198.5$
4. Mols. reflux = $\frac{10{,}410}{176} = 59.2$
5. Total overhead = 257.7

Therefore:

6. $V = 257.7 \times \frac{359}{3600} \times \frac{760}{30.5} \times \frac{723}{492}$
   = 941 cu. ft./sec.
7. $V_s = \frac{941}{200} = 4.70$ ft./sec.
8. $V_a = 7.1$ ft./sec. allowable vapor velocity.
9. Therefore, the per cent tower capacity utilized equals $\frac{4.70}{7.10} = 66.1$ per cent.

CONCLUSION

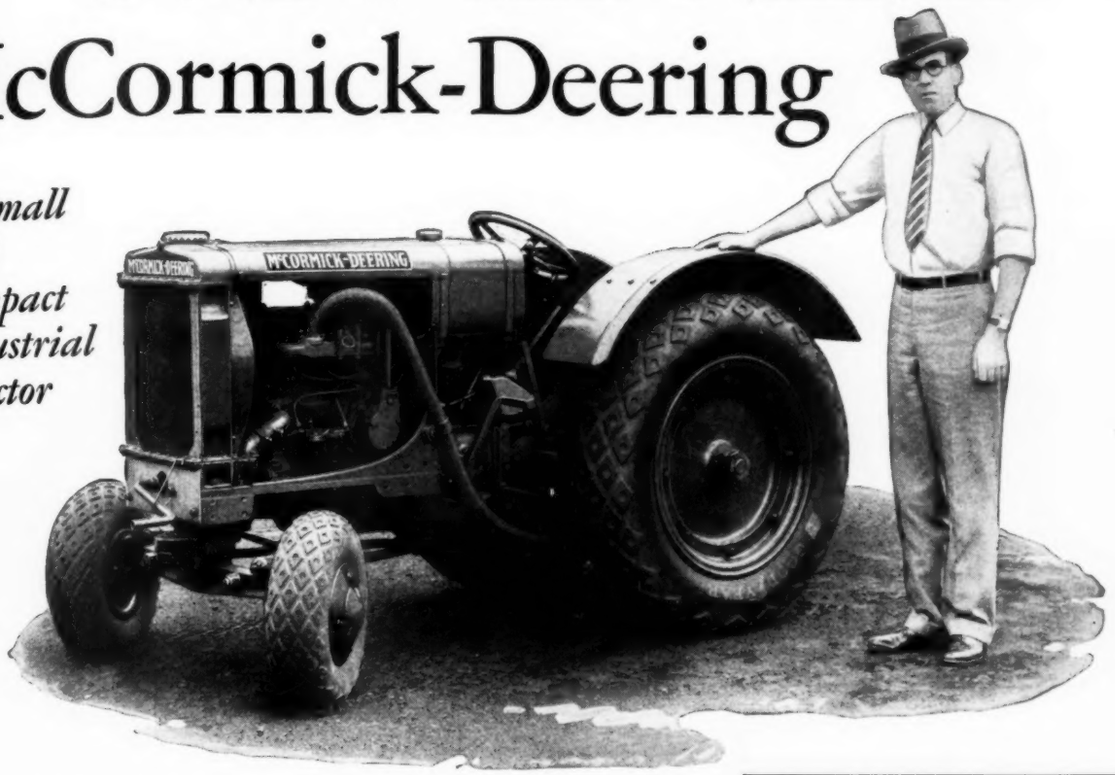
The subject of Vocational Refinery Mathematics is incomplete without mentioning a few statements that necessitate the use in many cases, of the elementary laws of physics and chemistry and certain mathematical formulae in addition to serving as a review of plant operations.

1. Steam-jetting from one atmospheric still to another to increase stripping efficiency.
2. Factors influencing the ring number of a kerosene as gravity and R.O. viscosity.
3. Advantages of square and round vacuum domes.
4. Function of barometric condensers.
5. Methods besides straight vacuum distillation that could be used to bring overhead a heavy stock.
6. Texas crudes from which water-white stocks are cut and average per cent cut from these crudes.
7. Pressure drop varies as the square of the velocity.
8. Efficiency of counter-current flow over parallel flow in heat exchangers.
9. High-pressure absorption vs. low-pressure for gas recovery.
10. Storage of gas in Hortonspheres under different conditions as size, pressure, thickness of steel.
11. Size and purpose of ring dams in centrifuging.
12. Advantages of vertical separator over horizontal.
13. The purpose of different absolute pressures on the evaporators of the Edeleanu Treating Plant.
14. Comparison of heat generation in air, gas and ammonia compressors.

(This concludes this series of articles on Vocational Refinery Mathematics by Mr. Washer. The attention of readers is drawn to the Addenda and Corrections for the entire series on page 78.—Editor.

Here It Is . . . the Model I-12 a NEW and Nimble McCormick-Deering

A Small and Compact Industrial Tractor



INTERNATIONAL HARVESTER announces the Model I-12—a New McCormick-Deering Industrial Tractor. The I-12 is small, compact, has a range of speeds from 2½ to 10¼ miles per hour, and turns in a radius of 8½ feet.

The International-built engine features replaceable cylinders, down-draft carburetion, induction-type magneto, oil air cleaner, oil filter with a metal element that is cleaned easily, and foot accelerator and hand throttle. Transmission and countershaft are *ball-bearing*—there are 17 *ball bearings* and 6 *tapered roller bearings* in the I-12. Steering worm is mounted on roller bearings.

The rear axle is designed for *uniform stress* to withstand shock loads all the way across. It is semi-floating, mounted on 4 ball bearings, and oil seals give protection against grit and dirt. Muffler, pintle-hook type spring-cushioned drawbar, and comfortable spring seat are regular equipment. Accessible machined surfaces are provided for mounting industrial equipment.

Ask the nearest International branch, or McCormick-Deering distributor or dealer, for information on the McCormick-Deering Model I-12. Write us for catalogs.

INTERNATIONAL HARVESTER COMPANY
of America
(*Incorporated*)
606 So. Michigan Ave. Chicago, Illinois

NRA MEMBER U.S. WE DO OUR PART

Brief Specifications:

Engine: 4-cylinder, valve-in-head type, 3-inch bore x 4-inch stroke. Speed variable to 2000 r.p.m.—foot accelerator and hand throttle controlled. Replaceable cylinders. Down-draft carburetor. Force-feed lubrication (drilled crankshaft). Thermo-syphon cooling. Oil filter. Oil air cleaner. Induction-type magneto. 8-inch single plate clutch.

Transmission: 3 speeds forward, 1 reverse. 2½ to 10¼ m.p.h. 4 ball bearings.

Frame: Two-piece construction. Transmission, countershaft and differential, rear axle, and final drive gears enclosed.

Front Axle: 4 tapered roller bearings for front wheels.

Rear Axle: Semi-floating, with 4 ball bearings. Oil seals.

Brakes: Internal expanding type. Operated by foot pedal.

Wheels: Low-pressure pneumatic tires. Front—6.00/9 (21⅓ inches o. d.). Rear—9.00/24 (42¾ inches o. d.).

Fuel Tank: Capacity—11 gallons.

Dimensions: Turning radius, 8½ feet; length overall, 96 inches; width overall, 50 inches; height over steering wheel, 52 inches; front wheel tread, 39⅜ inches; rear wheel tread, 40¾ inches; wheelbase, 60 inches.

Power take-off available.

Electrical Mitigation of Pipe Line Electrolysis

By R. T. FALKENBERG
Industrial Division, Houston Office, Westinghouse Electric & Manufacturing Company

EVERY year the pipe line companies of this country have heavy expenditures in digging up and reconditioning pipe lines that have been attacked by soil corrosion, which has been found to result from electrolysis. The U. S. Bureau of Standards estimates that the annual cost of this electrolysis is $142,215,000. This staggering figure is responsible for the extensive research being done to overcome corrosion and, during the past few years much progress has been made by employing electricity in what is known as "cathode protection."

Soil corrosion, or electrolysis, is caused by the flow of direct current off the pipe and the theory of cathode protection is to lower the potential of the pipe sufficiently below that of the surrounding soil so that any current will have to flow on to the pipe. Electrolysis on a pipe in the soil is similar in action to the electro-plating process. Currents passing from the pipe to the soil carry small particles of the pipe away, causing pits and, eventually, holes.

The mitigation of electrolysis by cathodic protection has been developed to a satisfactory point in the past two years and has been adopted by several pipe line companies operating in Texas, Louisiana, Oklahoma and California. Experimental investigations were conducted by placing a short section of bare pipe in a box of soil with carbon electrodes placed in a corner of the box and connected to the positive terminal of a battery. With the negative of the battery connected to the pipe, the voltage of the battery circuit was varied to give a number of differences in potential between the pipe and the soil. This test showed that pipe erosion stopped when the potential of the pipe was 0.3 volt less than that of the surrounding soil and, since this difference did not seem excessive for practical use, the experiments were continued in the field on a four-mile section of 6-in. pipe, using storage batteries for power. These field tests substantiated the results found in the laboratory and arrangements were made to continue the application by the introduction of a permanent power supply.

Application in the Field

The matter of a permanent power supply at the needed point involves the transmission of a.c. power at high voltage to the desired point, stepping it down to the proper value and converting it into direct current. This method has been found the most practicable, since, in most cases, pipe line companies own a telephone line paralleling their pipe lines that can be utilized in transmitting the a.c. power. In some cases where there was no pole line, pipe line companies have, with the cooperation of the power companies, constructed pole lines for transmitting the a.c. power to the needed point from the nearest existing high-voltage line.

Three methods have been used in converting the a.c. to d.c. but two of these are not practicable for an isolated station that may only be visited once or twice a month by a line-walker. Where the point needing protection is near an attended pumping station, motor generator sets and mercury tube rectifiers have been used satisfactorily, but it is only in very few cases that these stations are located so they can be utilized, and both the motor generator set and the mercury tube rectifier obviously have disadvantages that prevent their satisfactory operation at unattended stations.

The method of rectifying the a.c. power most widely used has been the Rectox unit. This copper-oxide rectifier has no moving parts, nothing to wear or burn out and, in case of power failure, will automatically start operating again as soon as power is restored. The most distinct advantage of the Rectox unit is its flexibility, whereby a station's capacity can be increased or decreased by adding or cutting out stacks. These stacks can be used in parallel or series parallel to give the exact voltage and current required. There are in operation at the present time stations using Rectox units ranging from 4 volts 2 amperes to 30 volts 200 amperes.

Only in certain types of soil is protection needed and even

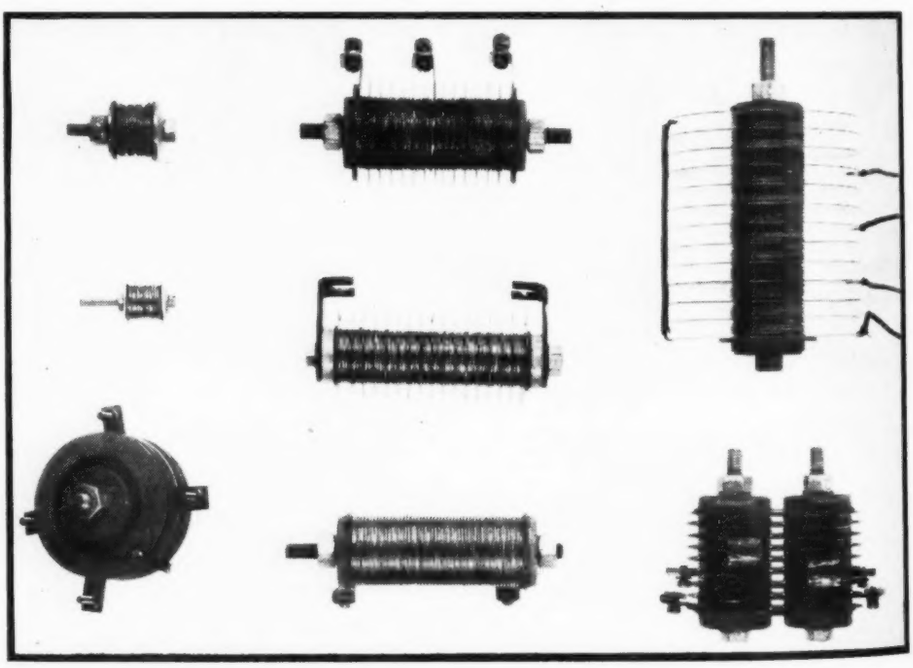
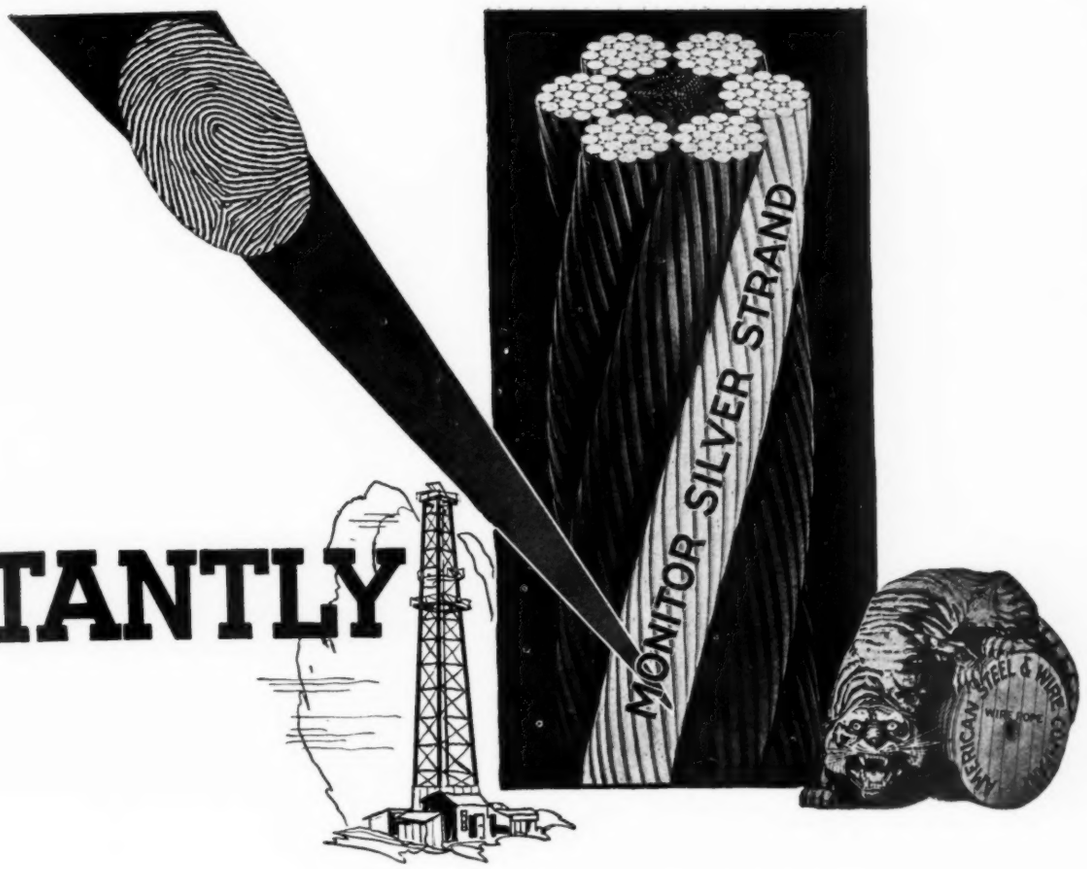


Fig. 1. Various types and sizes of Rectox stacks available.



A "FINGER PRINT" OF SILVER IDENTIFIES QUALITY!

FINGER PRINTS—positive identification of individual persons—find a perfect simile in the silver colored strand that runs throughout the length of American Steel & Wire Company Monitor Silver Strand Wire Lines. In this case, however, quality is the factor identified—positive assurance of superior performance and utmost economy. In Monitor Silver Strand Wire Lines—the strongest grade of steel used in wire line construction assures strength to spare. Also, of great value, are its lightness and abrasion resisting qualities.

AMERICAN STEEL & WIRE COMPANY

MONITOR

SILVER STRAND WIRE LINES

1831

1934

AMERICAN STEEL & WIRE COMPANY

208 South La Salle Street, Chicago
94 Grove Street, Worcester

SUBSIDIARY OF UNITED STATES STEEL CORPORATION
AND ALL PRINCIPAL CITIES

Empire State Building, New York
First National Bank Building, Baltimore

Pacific Coast Distributors: Columbia Steel Company, Russ Bldg., San Francisco

Export Distributors: United States Steel Products Company, New York

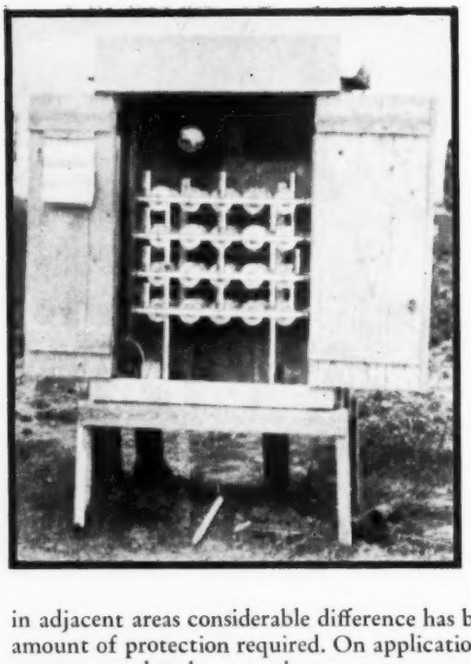


Fig. 2. A typical rectifying station for pole or platform mounting.

in adjacent areas considerable difference has been found in the amount of protection required. On applications made thus far no attempt has been made to protect more than 15 miles from a single station. The area that can be protected from one station depends upon the type of soil, the condition of the pipe and the capacity of the station. By means of an earth current meter the approximate required capacity can be determined and when Rectox units are used the number of stacks can be varied after the installation to give the exact output required. On installations requiring not more than 20 to 30 stacks, the complete outfit is assembled in a weatherproof housing suitable for pole or platform mounting. For installations requiring a larger number of stacks, a small house can be used and the equipment assembled and mounted in the house.

The equipment used in a typical station consists of a pole-type transformer for stepping down the purchased power to 110 volts, and inside the station is an entrance switch and a multiple-tap transformer for stepping the voltage down from 110 volts to the voltage required. This voltage is then rectified by a bank of Rectox units to direct current. The negative terminal of the d.c. is connected to the pipe line and the positive terminal is connected to a ground bed. These connections are made with a 300,000-cir. mils cable to eliminate voltage drop. This particular ground bed is placed about 500 ft. from and at a right angle to the pipe line and consists of 50 pieces of 6-in. cast-iron pipe ten ft. long set vertically in the ground and bonded together.

The rectified current is forced out of the ground bed into the soil, through which it passes to the pipe line to complete the electrical circuit. The current enters the pipe at points where the coating is defective and returns to the station through the pipe and connecting cable. The amount of current required to provide full protection to the pipe is in direct proportion to the number of abrasions in the pipe coating and the electrical resistance of the coating itself.

Results of Applications

A very conclusive test of protection, run over a considerable period of time, has been conducted by using coupons or bars cut from a pipe of large diameter. These coupons are highly polished and accurately weighed and are placed along the protected pipe line in pairs. One of the coupons is bonded to the pipe, which gives it the same protection as the pipe, the other coupon is buried in the adjacent soil with no protection. Fig. 3 shows a pair of these coupons that were removed after six months. Coupon VII was unattached and lost 3.22 grams weight and coupon XII was bonded to the pipe and lost no weight.

On one installation, during the three months prior to the application of protection 40 leaks in the pipe were found, and for two months following the application of protection no leaks were found. The pressure was then boosted for winter service and five more leaks were found. The customer attributes these to the increased pressure blowing out holes that were practically eaten through the pipe when protection was applied. No further leaks were found in the ensuing 13 months. On another installation 16 leaks were found in one mile of line during the first three weeks of March, 1933. Protection was applied the last week of March and there have been no leaks since.

Cost of Protection

The following figures are taken from a customer's report, the power cost being figured at 2½ cents per kw-hr.:

	Size of Line	*Type of Coating*	*Power Cost for Protection Per mile per year*
1.	6-in.	Coal tar enamel	$ 3.00
2.	18-in.	Coal tar enamel	$ 15.60
3.	9-in.	Hot asphalt	$ 88.00
4.	18-in.	Grease only	$490.00

The average cost of reconditioning these same lines, figured over a period of years and on the basis of the average cost per mile per year, is as follows:

	Size of Line	*Type of Coating*	*Average Cost of Reconditioning Per mile per year*
1.	6-in.	Coal tar enamel	$ 240.00
2.	18-in.	Coal tar enamel	$ 750.00
3.	9-in.	Hot asphalt	$1,100.00
4.	18-in.	Grease only	$ 750.00

From these figures it is evident that this protection provides a very substantial saving in reconditioning costs except on the greased line. It is not believed that this protection would prove practicable on bare lines or those coated only with grease; however, this cathodic protection[1] is considered practicable for all lines having a coating of fairly high electrical resistance, whether they are several years old with a large number of abrasions in the coating or whether they are newly laid.

[1]This method of protection also has been satisfactorily applied on underground cables.

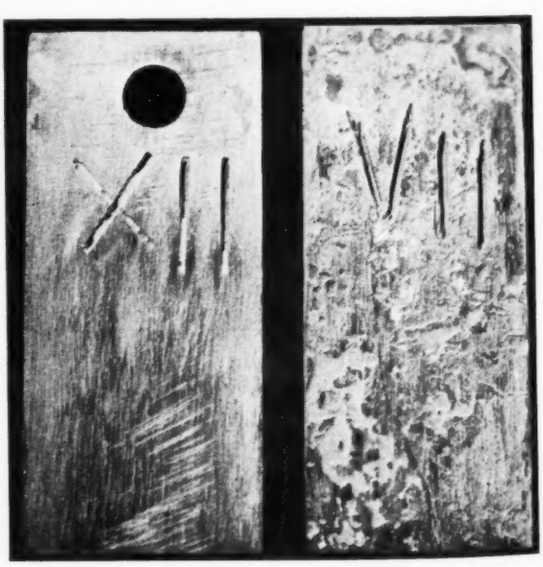


Fig. 3. Effects of soil corrosion in six months' time on two similar coupons; xii, protected; vii, not protected.

Another Use For Petroleum Coke

By J. L. MASSIE
Henry Vogt Company, Inc.

DUE to general expansion of its activities, the Dallas Cotton Mills Company, of Dallas, Texas, was forced to increase its steam generating capacity, which work has recently been completed by the Henry Vogt Company.

This installation is unique in that it is the first large industrial plant in the Southwest utilizing petroleum coke as fuel in a pulverized form.

The boiler unit consists of a Vogt 3-drum curve-type design of water tube boiler, containing a total of 4,060 sq. ft. of water heating surface, and in addition to this, 150 sq. ft. of steam heating surface. The commercial rating of the boiler is 460 b.hp., based on the evaporation of 34.5 lb. per hour of water, from and at 212 deg. fahr., and is designed for a working pressure of 200 lb. per sq. in., to conform to existing plant equipment. Steam is furnished at the throttle of an old-style Murray cross-compound engine at 150-lb. pressure, and one per cent saturated. The engine transmits its power to a lineshaft through a standard rope pulley driving arrangement.

The new steam generator is designed for a maximum capacity of 1000 b.hp. per hour, based on a maximum heat release of 25,000 B.t.u. per hr. per cu. ft. of furnace volume. This approximates 250 per cent operation.

A Kennedy Van Saun crushing mill is used to pulverize the coke, which is then force-blasted into the furnace in fine particles. An average of 82 to 84 per cent passing through a 200-mesh screen and with less than 0.5 per cent on a 50-mesh screen.

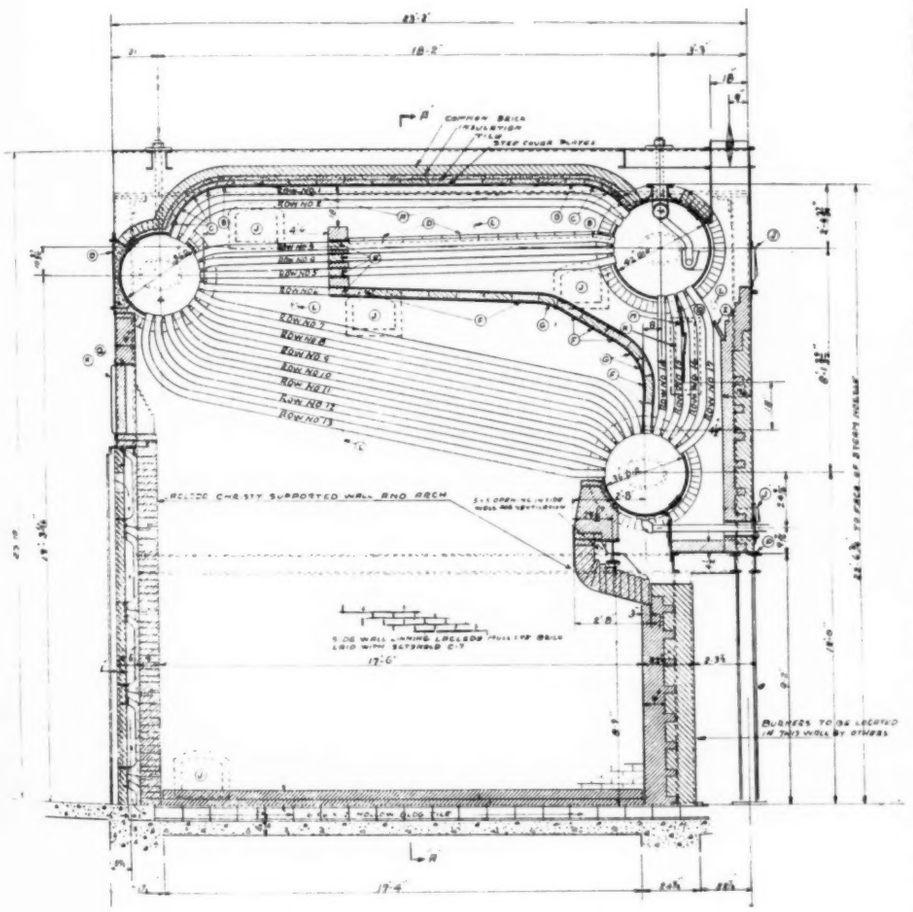
The source of the coke is at the local refinery of The Texas Company, where the coke is processed from Holmes-Manley cracking units.

The average run analysis of the coke, as fired, is as follows:

B.t.u. content per lb.	15,000
Ash content	0.5%
Sodium content	None
Petroleum content, volatile matter, 10.5 at	11%
Grindability of coke, per cent through 200-mesh screen	Non-abrasive at 82%

The furnace of the boiler incorporated the use of both the solid and air-cooled wall construction. The firing end of the boiler is the nominal rear end, in which a dutch oven effect is formed by installing a supported arch under the mud drum. The front wall, which is opposite the burner wall, consists of air-cooled wall construction, the air circulating from this wall through the floor ducts, and into the burner wind suction duct, helping to dry the pulverized coke, as fired.

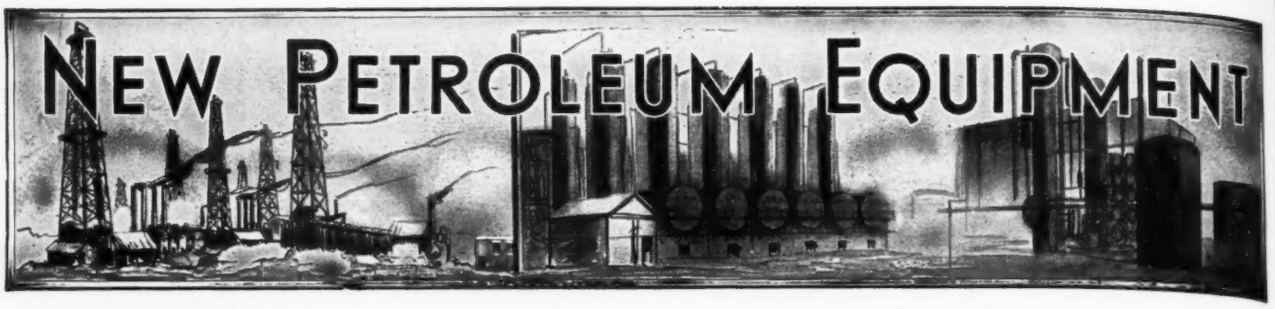
Boiler installation at Dallas Cotton Mills



The solid walls of the boiler are 22½-in. thick; the fire brick, as well as the hanging arch and wall tile, are all made from the Mullite Process by Laclede Christy Company, and sold under this trade name, the fusion point of this material being 3500 deg. fahrenheit.

For automatic shut-off purposes, the boiler is equipped with an Elliott triple-duty steam stop valve, and, for keeping the tubes clean, Marion soot-blowing elements are strategically located to keep all boiler surfaces clean from soot deposits.

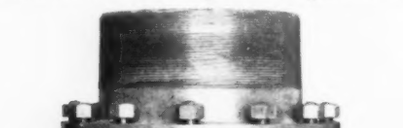
Due to the great amount of petroleum coke available in the Southwest, this installation may be the forerunner of providing another means of economically disposing of this refinery by-product.



Improved Safety Head

RECTOR Well Equipment Company, Fort Worth, Texas, announces an improvement in the Rector Casinghead for high-pressure areas, the development of an adapter gland, which makes for greater safety. Patent is now pending.

The adapter gland has an outside lathe-cut thread to give the operator a



simple method of stabbing over and screwing on relief equipment in the event of a blowout. It also provides a means of using a blowout preventer on the Rector casinghead, after surface pipe has been run, the head being on the surface pipe before the second casing string is run.

If a blowout should occur due to a break in upper connections, the Christmas tree can, with this new adapter gland, be backed out and a valve to fit the outside thread stabbed over the smaller flow. The adapter gland permits nippling up to be done immediately after cement is pumped into the well, if the operator wants to work the pipe while cementing.

The safety adapter gland is bolted on the top section of the Rector head in the same manner as the standard gland, which has an inside thread in the assembly's double collar.

Axelson Cage

A NEW cage design, offering greater strength to meet severe operating conditions, has been placed on the market by the Axelson Manufacturing Company. Realizing that more metal

was required at the wings of the cage to withstand conditions encountered in deep producing zones, Axelson engineers turned to a new method of production which produces a cage of long life and high operating efficiency. Instead of utilizing cylindrical milling, it will be noted that in construction the openings have been square milled. This particular cage permits the proper and successful use of the Axelson seat and drop.

The Heavy Duty Cage, made in both box type and pin type, is of four-wing construction, having a minimum amount of metal removed to produce the openings. The cage is hardened inside to provide a suitable wearing surface against which the ball or the drop operates. Having four wings, neither the ball nor the drop is permitted to flutter or spin, with the result that the moving member always lifts in a true vertical plane and is automatically centered upon the seat when the valve is in the closed position.

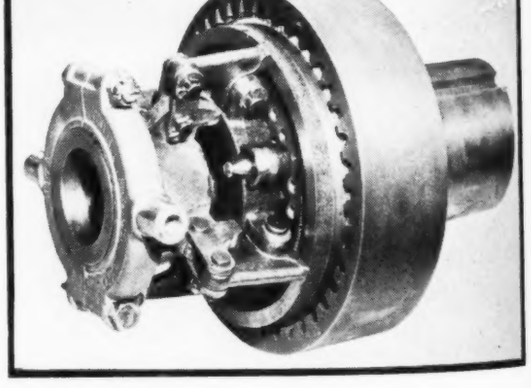
Based upon the diameter of a standard A.P.I. ball, the inside measurement between the wings allows a minimum amount of clearance that, again, prevents any fluttering or spinning of the ball—which action would normally shorten the life of the cage.

New B.F.T. Twin Disc Clutch Line

WITH a view toward standardization and simplification, and a reduction in the number of designs, the Twin Disc Clutch Co., Racine, Wis., recently completed the development of a new line of clutches, combining, the manufacturers state, all the good points of models B, F and T into one single model. This will be known as the B.F.T. series, and is intended to fulfill practically all requirements for this type of clutch, the capacities ranging from 3hp. per 100 r.p.m. up to 80 hp. per 100 revolutions per minute.

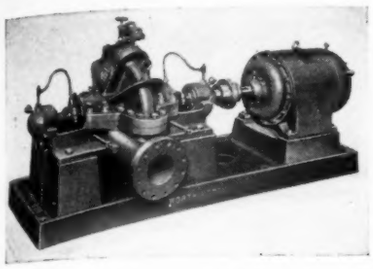
The series comprises eight sizes of clutches: 6½-in., 8-in., 10-in., 11½-in., 14-in., 18-in., and 24-in. The 6½-in. to the 14-in., inclusive, are made with one, two or three plates, the 16-in., 18-in. and 24-in. with one or two plates, as required.

In order that the B.F.T. line should be as complete as possible, the company also has developed suitable driving spiders for use with all the sizes, and for either one, two or three plates, as necessary. These spiders are available in three different styles, and are of the internal gear-tooth drive type. All clutches are of the toggle-action type, and in addition to using gear-tooth driving plates, have the inner plates that take their drive from the hub, driven in the same manner.



New Worthington Centrifugal Pump for Refiners

A NEW line of centrifugal pumps, developed specifically for the refiner and natural gasoline manufacturer, is being introduced by Worthington Pump and Machinery Corporation, Harrison, New Jersey.



Safety in operation has been assured by sturdy, liberally proportioned parts; casings have been made to withstand hydraulic pressures far in excess of the actual working pressures. Stuffing box leakage has been eliminated by incorporating these features: (1) extra deep water-jacketed stuffing boxes arranged with pressure breakdown and bleed-off connections, grease sealing glands and liberal packing space; (2) steel split smothering glands which smother with a stream of water any leakage which might get past this stuffing box packing, these smothering glands being bronze-bushed to prevent sparking; (3) shafts of ample diameter having low rotative speed below the lowest critical; (4) arrangement of stages such that, even in high-head pumps, the pressure on any stuffing box is not more than one stage above suction pressure.

Reliability is attained by employing features of proven merit. Oversize water-cooled grease-lubricated ball bearings are operated at practically no load by virtue of the hydraulically-balanced rotor. Packing life is lengthened by the use of hardened stainless steel shaft sleeves, operating at low rotative speed with entire freedom from whip, made possible by the extra large diameter shaft. Misalignment is prevented at all temperatures by the design and location of the water-cooled supports. The possibility of loss of suction or vapor binding is reduced to a minimum by vents on the suction volutes and on the first stage discharge volute, by the pick-up type of impeller, and by over-size high-pressure suction openings.

Low maintenance cost is the result of employing materials which have proved their ability to stand up under a wide variety of refinery services, and of such features as an all-metallic flexible coupling, low-packing wear, minimum power requirements in consideration of the service performed and the reliability maintained, and ease of access to all working parts without disturbing either suction or discharge piping.

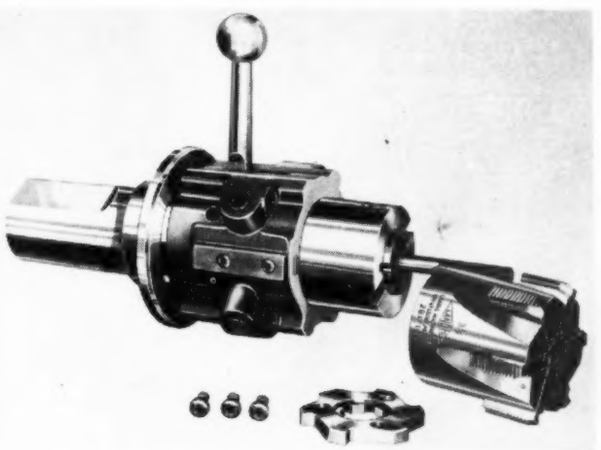
That this line of pumps will meet a variety of refinery requirements is evidenced by a steadily rising characteristic curve, high head per stage, oversize flanges adaptable to practically any special refinery flange requirement, water-jacketed stuffing boxes and oversize taps for vent and drain connections, the manufacturers state. Where required, lubricated vent and drain cocks can be furnished. For outdoor operation, a stuffing box covering can be provided.

These pumps are suitable for cold or hot liquids, either light or heavy, for operation against low or high pressures with low or high suction pressures. They may be used for stabilizer feed or reflux, propane transfer, hot recycle and a hundred other services encountered around the modern oil refinery. They are of the convenient, horizontally split casing volute type and are furnished in one-, two- and four-stage arrangements.

New Landis Collapsible Taps

THE LANDIS MACHINE COMPANY, Waynesboro, Pa., recently announced a new line of collapsible taps to supersede the Victor Collapsible Taps formerly manufactured by the Victor plant of the company. The new taps are made in two types: the Landis Style LT, a collapsible tap for either straight or taper tapping, and the Landis Style IM Receding Chester Collapsible Tap for taper tapping.

The outstanding feature of the new Landis taps is a design, on which patents have been granted, whereby the tap consists of two units: a tap body containing the operating mechanisms, and a tap head with which the chasers are supported. This design offers many advantages, since it permits the use of one tap body to cover a wide diametrical range by the application of tap heads of various sizes. In addition, the same tap body may be used for either right- or left-hand tapping, providing right- and left-hand tap heads are employed.



The collapsing mechanism of the Landis Taps is positive in its action, both with respect to locking the chasers in cutting position and in its collapsing action, the manufacturer states. The collapsing action is obtained through a hardened steel trip ring coming in contact with the part being tapped, thus insuring uniform thread length. The trip ring is adjustable.

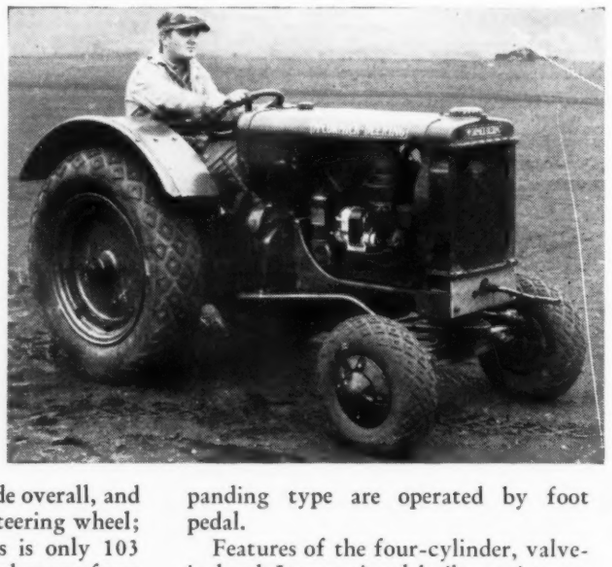
The tap heads are adjustable for size through an adjusting screw located in the form end of the plunger. The screw is self-locking and is of the ratchet type, so that a turn of one notch gives an adjustment to the chasers amounting to exactly .001 inch.

The chasers are supported in slots in the tap head and are held securely in tapered seats in a hardened and ground plunger. The design of the plunger is such as to provide maximum rigidity for the chasers and at the same time there is no tendency for the plunger to rotate under cutting strains and thereby force the chasers out of alignment. All locating surfaces, as well as the thread form itself, are precision ground.

The Landis Style LT Collapsible Tap is designed primarily for straight tapping, but can be used very successfully for tapping tapered threads of a length not exceeding the American Tapered Pipe Standards. The Style LT Taps are made in five sizes which, when equipped with the proper tap heads, cover a combined range from 1¼-in. to 13¼-in., inclusive. The Landis Style IM Receding Chaser Collapsible Tap is designed for tapping tapered threads. The receding chaser action minimizes cutting strains on this class of work with the result that greater accuracy and longer chaser life is obtained. The Style IM Taps are also made in five sizes covering a combined range from 1¼-in. to 12-in. pipe or 1½- to 13⅜-in. diameter.

New McCormick-Deering Industrial Tractor

THE NEW McCormick-Deering I-12 shown in the accompanying illustration is a small, compact, low-priced tractor that International Harvester Company, Chicago, Ill., has just added to its line of industrial tractors. For its size, the manufacturers state, it packs a lot of power (maximum engine power 21 hp.) and will prove useful on all sorts of industrial, commercial, construction, and municipal jobs where speed and ability to get in and out of close spaces are required.



The new I-12 is 96 in. long overall, 50 in. wide overall, and 52 inches high over the steering wheel; and its turning radius is only 103 inches. It has flexible speed range from a low of 2½ miles an hour up to 10¼ miles an hour, with foot accelerator and hand control. Brakes of internal-expanding type are operated by foot pedal.

Features of the four-cylinder, valve-in-head International-built engine are replaceable cylinders, downdraft carburetion, induction-type magneto, oil air cleaner, and oil filter with a metal element that may be easily cleaned. Efficient operation is facilitated by the use of 17 ball bearings and six tapered roller bearings. Easy steering is made possible by mounting steering worm on roller bearings.

The rear axle is designed for uniform stress to withstand loads all the way across. It is semi-floating and mounted on four ball bearings; oil seals give protection against grit and dirt. Muffler, pintlehook type spring-cushioned drawbar, and comfortable spring seat are regular equipment. Accessible machined surfaces are provided for the mounting of various types of industrial equipment to be operated by the tractor. The frame is of two-piece bolted construction. Transmission, countershaft and differential, rear axle and final drive gears are enclosed.

Cycloidal Rotary Pumps

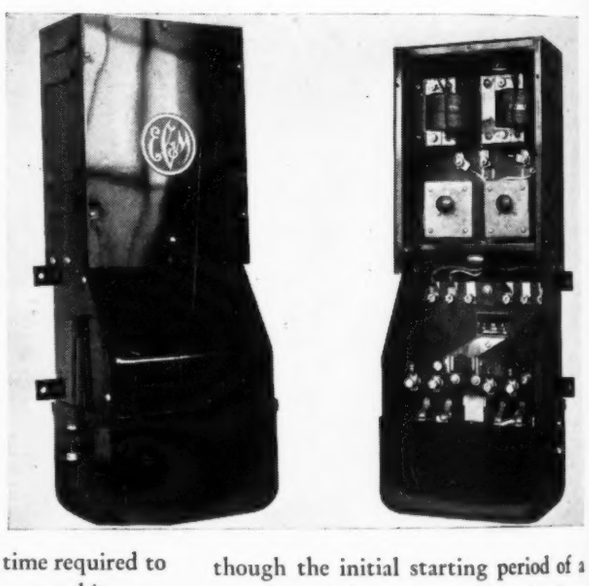
A COMPLETE LINE of Cycloidal rotary pumps is manufactured by the Roots-Connersville Blower Corporation, Connersville, Ind. These pumps are built on the two-impeller principle, with two- and three-lobe impellers, depending upon the type of service to which they are applied.

Cycloidal rotary pumps are built for heavy-duty service, including the handling of viscous liquids, or for producing vacuums up to 26 in. Hg. (or approaching the barometer under special conditions), handling air and liquids simultaneously. Simplicity of design and sturdiness of construction are emphasized by the manufacturers as desirable features.

The Type "R" pump is a comparatively recent development of the Cycloidal design that the company has used over a long period of years. In this pump, the cylinder is made integral with the base, with the inlet at either side to suit individual plant piping conditions. Discharge is at the top. Large diameter shafts are supported on four anti-friction bearings. Timing gears are machined from forged steel blanks, and heat-treated. Bearings and gears are protected from contact with the fluid, being handled by improved stuffing boxes.

Any standard driving arrangement is available but the company features single pulley, direct-coupled and V-belt pumps, operated by gasoline engine and electric motor.

New Type Centrifuge Motor Starter



FOR USE in connection with refinery centrifuges, the Electric Controller & Manufacturing Company, 2710 East 79th Street, Cleveland, Ohio, announces the EC & M Type ZO Centrifuge Motor Starter. This is a heavy duty, oil-immersed starter especially developed to provide adequate single-phase and overload protection for the motors used on these machines. Due to the long time required to bring these motor-driven machines up to speed, the overload device employed in starters for this service must be so designed that they will not trip during the long starting period, yet must be set at a current value low enough to protect the motor against single-phase and overload conditions during running.

The overload relays used in the new EC & M Starters are so designed that they practically duplicate the sensitive and accurate protection afforded by a standard starter. This means that, although the initial starting period of a centrifuge is between five and six times longer than that of the ordinary motor-driven machine, adequate overload protection is assured by the use of current-limiting transformers so that the relays do not trip under the excessive current conditions during starting, the manufacturers state.

The relays can thus be set at a value low enough adequately to protect the motors against small overloads and single-phase operation when the motor is running at full-load rated speed.

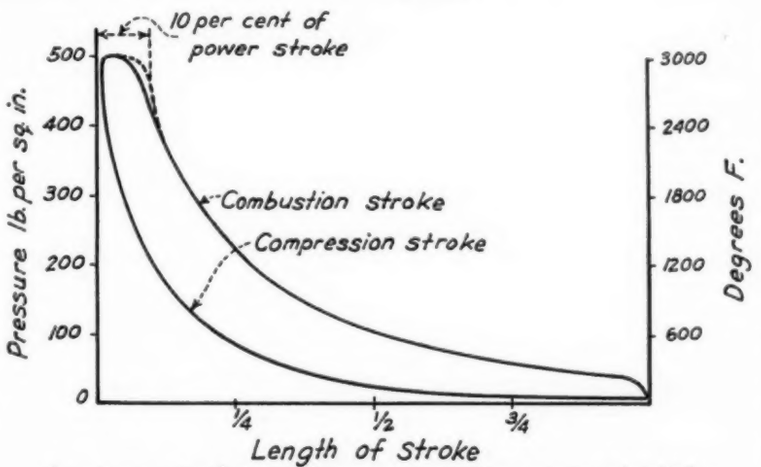
Problems of Heat Control In Diesel Engine Operation

By SAM MONROE
District Machinist
Stanolind Pipe Line Company

IN a discussion of temperature control in the Diesel cylinder, there are many factors to be dealt with, such as combustion, proper alignment of all moving parts, correct fitting of bearings, and the skill and efficiency of the operator, to mention only a few of those things contributing to this important feature of Diesel engine operation.

Experience has demonstrated that the factors responsible for damaging temperatures are interrelated. Since it is difficult to develop the subject by attempting to write of each particular factor in a manner applicable to a specific case, it is the writer's intention in this article to consider combustion in relation to proper temperature control.

A leaky exhaust valve not only will raise the temperature in a cylinder above normal, but the greatest harm comes from the resulting uneven temperature. This distorts the liner, piston and piston rings at the point of greatest exposure to exhaust valve temperatures, seriously impairing lubrication, and in turn leading to a further rise in temperature due to added friction at that point. If an engine is allowed to operate too long under this particular condition, excessive wear will result and the metal will actually set to an out-of-round shape on the surfaces exposed to the uneven heat.



A pressure equal to maximum compression pressure should be maintained throughout ten per cent of the power stroke

In the case of practically all standard makes of air-injection Diesel engine the combustion should begin at dead center, or slightly before. This will vary, but never will combustion begin more than four degrees in advance of dead center. Combustion should continue while the piston is traveling ten per cent of the length of the power stroke. Injection of fuel must be accomplished in a manner that will not cause a rise in pressure of more than 25 lb. and that will enable a constant pressure to be maintained during the entire time of combustion. This condition is more easily possible when commercial grades of oil are used as fuel instead of the crude oil commonly used in pipe line stations.

The operating engineer must take into consideration the gravity of the fuel oil and adjust vital parts of spray valves and injection air accordingly. The atomizers in most Diesel engines are designed and balanced for 18-gravity fuel, and when an engine so designed is operating on a 35-gravity fuel, either more restriction must be added to the atomizer and nozzle or lower injection air should be maintained. In any event the lift of the spray valve should not be shortened, inasmuch as this causes shocks and excessive heat at the instant of combustion, even when pyrometer readings on exhaust lines indicate a lower exhaust temperature.

A low exhaust temperature is not always an indication of a desirable combustion condition. This is true only when the lowest exhaust temperatures exist, following a uniform pressure and temperature condition during the period of combustion. Faulty combustion, due to failure in observing the circumstances leading up to a state of well-balanced pressures and temperatures during the combustion period, will develop unequal temperature in the cylinder, piston and rings, bringing about ring failure due to distortion through over-heating at certain spots on the outer circle of the ring. The ill effects of this condition are cumulative and, unless heat and pressure control are given due consideration, likely will create a baffling problem.

Quite often lubricating oil is wrongly blamed for failure or damage that, in reality, results from neglect of working parts. Expensive piston rings that will partly offset these troubles temporarily can be installed, but when the proper temperature control is understood by the operating engineer (assuming, of course, the engine is not overloaded) there is no reason why any moderately priced lubricating oil or piston rings, made by reputable firms, should not give the desired results.

The writer has engines under his care in a number of plants that are equipped with the common cast-iron piston rings. After seven years of continuous operation, in old liners with the normal amount of wear, it is found that better service is actually being obtained from these rings since paying close attention to cylinders and temperatures than when the cylinders and rings were new. Through correcting conditions of combustion and taking advantage of the things we know about control of temperatures, we have eliminated at least 75 per cent of engine repairs and failures, reduced crankcase contamination of lubricating oil and, as we gain in knowledge of this particular phase of Diesel engine operation, we find that all our former troubles have decreased in proportion.

In classifying the Diesel engine and treating the theory of combustion of the various types that are on the market, the semi-Diesel and solid-injection type engines must be managed in keeping with their particular design. The principles outlined in this article are applicable only to the engine designed to full Diesel compression of 500 lb. at sea level, air-injection type.

In articles to follow the writer shall discuss other practices observed that are interrelated to factors described in this article.

You Can Save Your Investment

Many Times over

by Installing AXELSON Pumps & Rods in every well

AXELSON MANUFACTURING CO.

P. O. Box 710, Vernon Station, Los Angeles

St. Louis 50 Church St., New York Tulsa

Mid-Continent and Eastern Distributor:
Frick-Reid Supply Corporation

Rocky Mountain Distributor:
Great Northern Tool & Supply Company

The Petroleum Engineer Publishing Company,
P. O. Box 1589, Dallas, Texas.

Date .....

Enter my subscription to The Petroleum Engineer from above date for one year, to be sent to me at address below, for which I hereby hand you (check) (cash) in the amount of $1.00 ($1.65 in Canada).

Name .....

Company .....

Title .....

(To avoid delay, please do not fail to state your title.)

Street of Box No. .....

City ..... State .....

Country .....

Addenda and Corrections—Vocational Refinery Mathematics

ARTICLE I—November, 1933, Issue:

(Explanation). Formula (13), p. 44, refers to the calculation of the latent heat of vaporization of petroleum oils in the solution of problems pertaining to stills, etc., and is based on calorimetric measurements of petroleum distillates, practically all measurements being made at atmospheric pressure.

(Corrction). Formula (14), p. 44, should read:

$$\frac{1}{\sqrt[2]{d}} = (0.388 + .00045t)$$

(Correction). Formula (15), p. 44, should read:
1.000 — [(60 — T) × coeff. of expansion]

ARTICLE II—December, 1933, Issue:

(Correction). Formula (21), p. 43, should read:

$$\frac{y - s}{s}$$

(Correction). Under example, formula (33), p. 45, read:

$$\frac{42 \times 1000}{3600 \times 7.48 \times 6.07 \times 6.07 \times (785/144)} = 7.77 \text{ ft./sec.}$$

ARTICLE III—January, 1934, Issue:

(Correction). Under example, formula (35), p. 49, read: To find the diameter of a pump piston to handle 600 gal. per min. at 75-ft. piston travel.

(Correction). Under formula (45), p. 50, read:
Cos Φ = Power factor of motor, watts/(volts × amp.), assume 0.9 to 1.

(Correction). Under example, *Part* 2, formula (45), p. 50, read:
(1×42×315×.44×100)/(60×7.48×33,000) = 128 horsepower.

ARTICLE IV—February, 1934, Issue:

(Correction). Formula (57), p. 52, should read:

$$E = \frac{H_0}{H^1}$$

(Correction). Example under formula (62), p. 55, should read:

$$K = 0.86 \times (1) \times (1) \sqrt{1/18} = 0.33.$$

(Correction). Under example, formula (62), p. 55: In example of the general formula, (62), read (61) instead of (62).

(Correction). In formula $\frac{Due}{Z} = 3 \times 2 \times \frac{50}{1.5} = 205$, read 200 instead of 205.

(Correction). Under: From Curve No. 1 (see chart, Fig. 3), read:

$$\Phi \frac{Due}{Z} = 1600.$$

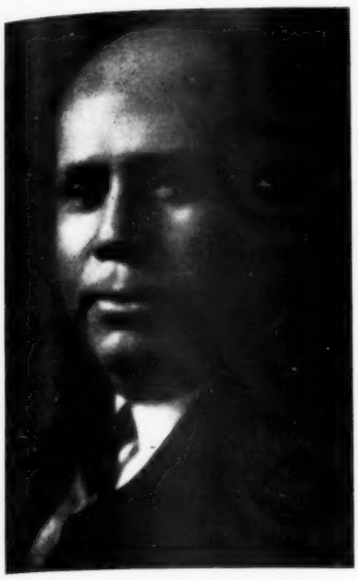
(Correction). In formula $\frac{CZ}{K} = \frac{.51 \times 1.5}{0.78}$ read .078 instead of 0.78.

(Correction). Under: From Curve No. 3, read:

$$\Psi \frac{CZ}{K} = 2.3.$$

(Explanation). Referring to Fig. 3, p. 54, the ordinates 1 to 2000 as shown are for curves Nos. 1 and 2. For curve No. 3 the ordinates 1 to 100 have one-tenth the value shown, or from 1 to 10.

Tom Cranfill Passes Away



Thomas E. Cranfill, well-known independent oil man of Dallas, Texas, died Tuesday morning, March 6, following an illness of two months. Death was caused by complications following an operation for appendicitis.

Mr. Cranfill became identified with the oil industry during the Spindletop boom, when he was 20 years old, and subsequently participated in the development of many of the major pools in the state of Texas, among them being Ranger, Wichita Falls, Mexia and East Texas. At the time of his death he was regarded as one of the most important independent operators in the East Texas field.

Born at Turnersville, Coryell County, Texas, August 23, 1881, the son of Dr. and Mrs. James Britton Cranfill, he received his early education in the public schools and later attended Baylor University at Waco. He took up his residence in Dallas in 1898 and four years later married Miss Mai Seay, daughter of Ben T. Seay. He entered the real estate business with his father-in-law, operating under the name of Seay-Cranfill Company. Later, however, because of extensive oil interests, he abandoned the real estate business.

In addition to his oil interests, Mr. Cranfill took an active part in church, civic and educational work.

He is survived by his parents, Dr. and Mrs. J. B. Cranfill; his widow, four daughters, Mrs. Robert L. Clark, Misses Bettie and Eleanor Cranfill, of Dallas, and Mrs. Charles Campbell, of Lampasas, Texas; one son, Tom Cranfill, Jr., Dallas; a sister, Miss Mable Cranfill, and a grandson, Robert L. Clark, Jr., Dallas.

Smith Agency Adds Vice President's Name

Smith, Schreiner & Smith, Inc., Pittsburgh, Pa., has changed its middle name. The new name is Smith, Hoffman & Smith, Inc. No change of agency principals is involved. Charles F. Hoffman continues his duties as vice-president, and the agency remains under the direction of the founder, Lambert Smith, who is also secretary-treasurer of the First Inter-Agency Group.

CHARLES F. HOFFMAN

● HYDRAUGER ●
MODERN HORIZONTAL BORING MACHINE
For Underground Installation of Pipe and Conduits. Avoids damage to costly pavements and saves time. Send for Bulletin.
HYDRAUGER CORPORATION, Ltd.
343 Sansome St. San Francisco, Calif.

B PRODUCTS for pumping wells
The KEY to LOWER LIFTING COSTS
CORRECTLY DESIGNED • • ECONOMICALLY PRODUCED
REASONABLY PRICED

B-M-W TRIAD CUPS
Last Longer . . Perform Better
A trial will convince you that here is the finest Composition Cup made . . . ask your Supply Store.

BRADFORD MOTOR WORKS INC.
OIL WELL SUPPLIES
BRADFORD, PA. TULSA, OKLA.
EXPORT OFFICE—30 CHURCH ST.—NEW YORK CITY

Look for the Arm-and-Hammer Seal
ARMSTRONG BROS.

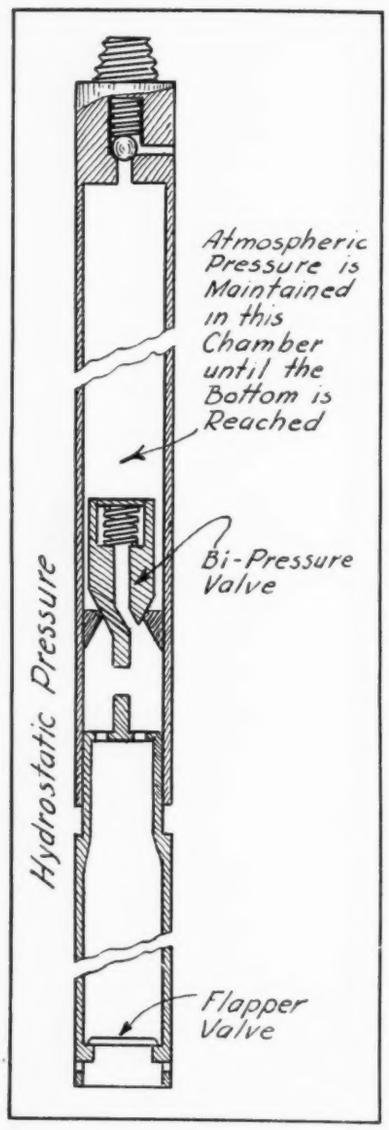
IN OIL FIELDS, where extra strength is needed, where Tongs must stand up under abuse, day after day, these stronger tongs that are forged from special steels, treated jaws and proof-tested chains are becoming standard equipment.

Write for Catalog of Improved Pipe Tools
ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
331 North Francisco Avenue
CHICAGO, U.S.A.
Mid-Continent Representative
EARL WADDELL
Fair Bldg. Fort Worth, Texas

Utilizing High Hydrostatic Pressure In a Well for Cleaning-Out

By
WALLACE A. SAWDON
Petroleum Engineer
Los Angeles

Steel Springs and Other Elusive Pieces of Junk Brought Up with Sand Pump Operating on Hydrostatic Principle


Atmospheric Pressure is Maintained in this Chamber until the Bottom is Reached
Bi-Pressure Valve
Hydrostatic Pressure
Flapper Valve

Diagrammatic drawing showing the principle of the hydrostatic sand pump

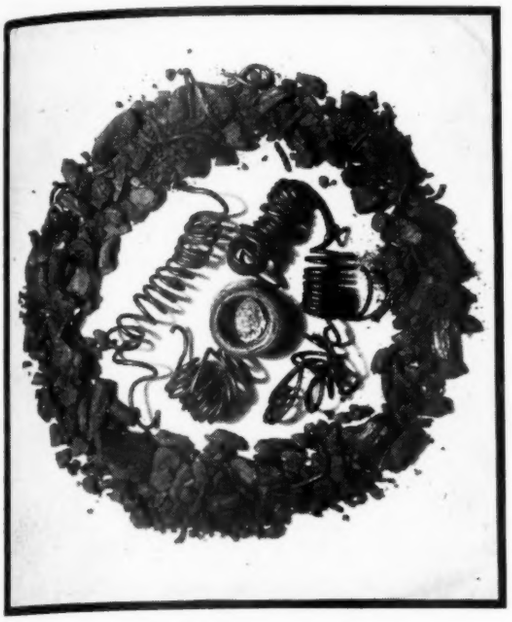
DIFFICULT clean-out jobs are frequently the cause of decreased production and, in some cases, the real reason for the abandonment of a well. The cost of rigging up and running cable tools has probably been influential in preventing a great deal of cleaning out but there are many cases where the methods tried have been unable to cope with the conditions encountered. Even drilling wells where rigs are available for use in cleaning out sometimes get into such a condition that further progress is difficult and expensive. This is especially true, perhaps, where a well is temporarily shut down and where junk and cavings have been allowed to accumulate in the bottom of the hole. Such was the case of the W. E. McCaslin well, Transport No. 17, in the Huntington Beach field, California, where a clean-out job that seemed almost impossible of accomplishment was finally done with a hydrostatic sand pump.

Some clean-out jobs verge on becoming serious fishing jobs when pieces of metal form part of the junk that has accumulated at the bottom of the hole. The electro-magnet[1] may play a part in recovering such pieces of metal when they are known to have been lost and are not covered up with cavings. When the metal pieces, however, consist of steel springs that are not firmly imbedded in the formation but are free to bounce around in the more or less loose material that has accumulated in the bottom of a hole, the difficulty in recovering them, as well as in drilling them up, can readily be understood. While the contents of the material lodged in the McCaslin well were not known until it was cleaned out, it is the opinion of the writer that pieces of steel spring that were brought out of the hole prevented success in the various attempts to clean the well out before the hydrostatic type of sand pump was used. They at least demonstrated the power of this type of sand pump and indicated its adaptability to all kinds of clean-out jobs. The history of this well shows that it was, perhaps, an extreme case. It was started as a deep test in 1931 and drilled to 8365 feet. It was tested at several levels below 5800 ft., and flowed oil of 27 gravity A.P.I. for a short time. Mud and water, however, indicated a faulty shut-off and several shots below 7800 ft. failed to improve it. A string of 4¾-in. casing was perforated at about 6000 ft. and approximately 600 ft. of 3-in. liner was later run in.

Mud weight material was used as a safety measure when the well showed any inclination to flow and this seemed to accumulate and harden between the liner and the formation. Plugs were set and drilled up. Later, after shooting, a bridge formed.

Attempts were then made to clean out and several different methods were used. Bailing was tried with several types of sand pumps but no successful results were obtained. Cable tools were finally rigged up and run into the hole; and after much difficulty reached the bottom. Another flow test was then made but the well bridged at 7800 ft. and further attempts at cleaning out failed. Operations were then suspended.

[1] "Electro-Magnet Used to Recover Metal from Oil Well," by Wallace A. Sawdon, *The Petroleum Engineer*, November, 1933.



Junk taken from the McCaslin well on the first run of the hydrostatic sand pump. Flapper valve, through which all this passed, is shown in center. The high pressure utilized squeezed pieces through the valve that could not be forced or worked through by hand.

After the hole had been allowed to remain in this condition for about 18 months, further attempts to clean out the well were started a few months ago. Again various types of bailers and sand pumps were tried out. Circulating and rotating with diamond-point bits were also used; but with no results.

It was then that the hydrostatic sand pump described below was used in the well; and since the 3-in. liner was at the bottom it was necessary to run a $1\frac{7}{8}$-in. size pump. The hole was filled with junk, sand and other foreign matter from its total depth of 8365 ft. up to 7800 ft., where it had bridged. It was also full of fluid, which consisted of water, mud and a little oil, and thus had a hydrostatic head of over 3000 lb. per sq. in. where the cleaning-out was started.

The tremendous pressure this made available for the operation of the pump produced some startling results. In the accompanying photograph is shown some of the junk that was recovered, together with the flapper valve and the shoe through which the pieces passed. It was only because of the sudden, tremendous pressure applied that the springs illustrated could be forced through the 1-in. flapper valve and the larger pieces of slips forced into the shoe. All the pieces shown were taken out with one run and they were capped by a plug of soft rope found in the lower tube section. Probably the greatest difficulty experienced on the job was in getting the wedged junk out of the pump.

While the hydrostatic type of sand pump has been used in the oil industry for several years, it is doubtful if its power, especially in deep wells filled with fluid, is fully realized. The principle is that of a tubular chamber lowered into a hole with the pressure within the chamber maintained at atmospheric, or about 15 lb. per sq. inch. As the chamber descends through the fluid in the hole, the pressure outside this chamber builds up until the clean-out point is reached. Assume this point is 7000 ft. and the hole filled to the top with water. Outside the chamber is now a pressure of over 3000 lb. per sq. inch; inside is the negligible atmospheric pressure of 15 lb. per sq. inch. By a sudden opening of a valve at the bottom, the 3000-lb. pressure is admitted to the chamber and this differential, which is practically the entire hydrostatic pressure at the depth to which the sand pump is run, is applied to anything around the bottom of the tool.

The type of sand pump used in the McCaslin well consists of two tubular sections connected by an automatic bi-pressure valve. The lower section, or chamber, fills with a clean fluid as soon as the pump reaches that fluid. The water, mud or oil, however, cannot pass up into the upper chamber since the bi-pressure valve retains its seat until the bottom is reached.

When the hydrostatic sand pump reaches the bottom, the weight of the upper section that carries the valve assembly, compresses a spiral spring and permits the upper section to telescope over the lower section. As the former descends, the bi-pressure valve contacts a riser placed in the lower section. This riser forces the valve off its seat.

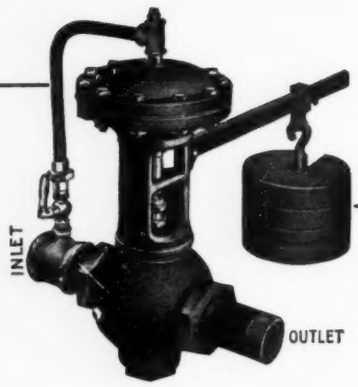
The upper chamber has, until this time, contained nothing but air at atmospheric pressure. With the sudden opening into a chamber, the pressure inside which is so small as to be negligible, the well hydrostatic pressure (which in the case of the McCaslin well was over 3000 lb. per sq. in.) will naturally force the fluid from the lower chamber past the bi-pressure valve and into the open chamber above. It will just as naturally drive whatever loose particles the pump is resting on into the lower chamber to take the place of the fluid that has left it.

The suddenness of the action, together with the great pressure applied, makes the force somewhat explosive in nature. It is interesting to note, however, that the bi-pressure valve showed no sign of cutting after being run in the McCaslin well. In spite of the pressure encountered, there was also no leaking of fluid past the valve and into the air chamber.

The springs that passed through the flapper valve and into the lower chamber could not be forced through by hand after they were brought to the surface; and the pieces of metal that wedged in the shoe seemed to be too large even to be forced into the place where they lodged. The well was readily cleaned out to its original depth of 8365 ft. and thus put into condition for further operations.

The parts of the sand pump remained uninjured and are shown here after use in the McCaslin well. The bi-pressure valve is standing upside down from its position in the tool.

While the operation described above was in a drilling well, it gives an extreme case and indicates the action of the hydrostatic sand pump under adverse conditions. In cleaning out producing wells, it requires no rigging up of tools, since it is run on the line. The higher the fluid is in the hole, the greater the force applied to the pump; but the great power applied in the McCaslin well will never be necessary for the average clean-out job.



Speed Pump Regulation
Made Definite and Sure

EXCESS discharge pressure is relieved, discharge kept constant, and operation of the compressor at full speed made safe, by use of the C-F Compressor Regulator. As a close regulator of pressure on electric-driven pumps, it stands unrivalled. Gas, steam, air, water—in all such applications the C-F Compressor Regulator is thoroughly dependable. The lever type is here shown. A spring loaded valve is also available and is equally sure in operation. Excess discharge pressure flows through without noticeable variation in suction line. Ask for descriptive pamphlet, also Catalog of Chaplin-Fulton regulators for all requirements of gas-pressure control.

The Chaplin-Fulton Manufacturing Company
28-40 Penn Avenue Pittsburgh, Pa.

CF Compressor Regulator

HOTEL BILTMORE

. . . in Oklahoma City, combines all the features of the modern metropolitan hotel at its best. All rooms have three-channel radio and every other possible convenience.

You'll find the food and service in both the Main Restaurant and Coffee Shop in keeping with Hotel Biltmore standards. The Hotel's downtown location makes theatres and shops easily available.

Room rates start at $2.50.

TRADE LITERATURE

COLMONOY, INC., LOS NIETOS, CALIFORNIA, has recently issued Bulletin 30, which describes in detail the company's various hard-facing products, all of which have as their base Colmonoy crystals, a new metallic boride. J. B. Reilly and R. C. Grinnell, of the Fluid Packed Pump Company, are associated with the new company. A. B. Leonard is the sales manager.

All Colmonoy products have two outstanding features: a combined property of toughness and hardness, and a low specific gravity, the manufacturers state.

One of the principal products made by Colmonoy, Inc., is Colmonoy "Sweat-On," which they recommend for use on parts subjected to extreme shock, abrasion and oxidation. According to the manufacturers, it opens a new field to hard-facing and permits the economical solution of many problems formerly considered impractical. It is applied oxy-acetylene or electric. Bulletin 30 will be mailed upon request.

THE LANDIS MACHINE COMPANY, Tap Division, Waynesboro, Pa., has for distribution two bulletins giving detailed information and complete specifications of the new Landis Collapsible Taps. The Style LT Collapsible Tap for straight tapping is covered by Bulletin No. G-83, while the Style LM Receding Chaser Collapsible Tap for tapered work is covered by Bulletin No. G-81.

METALLIC PACKING CATALOG. Metallic packing for every standard use in connection with steam, air, gas, gaseous ammonia and carbon dioxide equipment is shown in a new 36-page catalog of the American Metallic Packing Company of Pittsburgh, Pa. Special engineering service is offered by this company where unusual conditions require individual design and emphasis is placed on packing for high-pressure compressors up to 1200 lb. and similar installations.

DIESCHERIZED PIPE AND TUBING is the title of a new bulletin published by The Babcock & Wilcox Tube Company, Beaver Falls, Pa. This bulletin, the first published on this subject, is arranged for quick, easy reading, and contains the more important facts about the Diescher Process.

THE LEACH HIGH-PRESSURE FRACTO CONDENSER is designed for installation on cracking coils in the vapor line between the vaporizer and the bubble tower. The cooling medium is either hot feed to the cracking coil under full pump pressure or reduced crude fresh feed or crude being heated for stripping. This condenser and many engineering features are discussed in a bulletin published by the C. H. Leach Company, 11 Park Place, New York City.

THE SILVER COMET SIX, a compression ignition engine manufactured by the Waukesha Motor Company, Waukesha, Wisconsin, is fully described and illustrated in an attractive bulletin issued by the company as Engine Bulletin No. 914. The Silver Comet Six is used for motor coaches, tractors, trucks, pumps and electrical and industrial machinery.

Appoint New Gulf Coast Distributor

The Gray Tool Company, Houston, Texas, has become associated with the Oil Field Engineering Corporation and Petroleum Equipment Company of Fort Worth, Texas, as representatives in the Gulf Coast and South Texas districts. Complete warehouse stocks will be maintained at Houston, with active field representation.

Union Wire Lines In Mexico

The Union Wire Rope Corporation has announced the appointment of Señor Enrique O. Chapa as sales representative in the Republic of Mexico.

Señor Chapa has been identified with the oil industry since 1921, first with the El Aguila Oil Company, and later with the Mexican Gulf Company, both at Tampico. He is a native of Matamoros, Tamps. The Chapa family is one of the oldest in Mexico. His brother, M. J. Chapa, is treasurer of Ferrocarril Oriente Y Pacifico. Señor Chapa's headquarters will be at Washington 111 Oriente, Monterrey, Nuevo Leon, Mexico.

The distribution of Union Wire Lines in foreign fields is reported to have been growing steadily. Their already extensive use in Mexican fields has, the Company states, warranted them in seeking special representation in Mexico.

Merco Nordstrom to Open New District Office

The Merco Nordstrom Valve Company of Pittsburgh, Pennsylvania, subsidiary of the Pittsburgh Equitable Meter Company, announces the establishment of a new district to serve the territory of Central and Western New York State. C. F. Thomas, who has been acting as New York State representative for a number of years, will be district manager in charge of the new territory, assisted by D. A. Gardner, who has also represented the company in the past in various sections of the country.

An office will be opened at some point in this territory in the near future, the exact location to be announced as soon as negotiations have been completed.

Will Represent Venezuelan Government

The Axelson Manufacturing Company announces that C. C. McDermond, sales representative for the company in Venezuela and Colombia, has been appointed by the Venezuelan government as official representative at the forthcoming International Petroleum Exposition to be held at Tulsa, Oklahoma, May 12 to 19. Mr. McDermond acted in the same capacity for the Venezuelan government in 1930.

Immediately following the exposition, Mr. McDermond will visit Axelson's St. Louis and Los Angeles factories, where he will renew old acquaintances and observe the new processes used in the manufacture of Axelson products.

ENGINEER with Process and Apparatus for Freeze Proof control of High Pressure Gas Wells would like to get in touch with companies and individuals having trouble with such wells.

ADDRESS BOX 222, Care of PETROLEUM ENGINEER

KOBE
HEAT-TREATED
SCREEN
CASING

KOBE Incorporated
Los Angeles California, U.S.A.

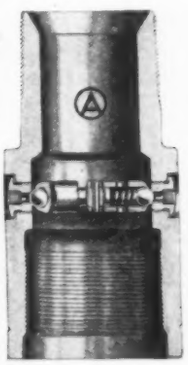
SLUSH-MIX..
The ideal rotary mud.
GELITE..
The improved gel for all mud mixtures.
MUD-FLUX..
A mud thinner.
FISSURSEAL..
For lost circulation, etc.
KLEEN-A-WELL..
An Oil Well Reviver. Removes paraffin.
SULCO OIL FIELD PAINT, BOILER TREATMENT
.. and other technical products.

SULCO LIFE PRESERVERS FOR THE OIL FIELDS PRODUCTS

The SULLIVAN *Co.*
Memphis, Tenn., U.S.A. *Cable Address: Sulco*

AXELSON
TUBING BLEEDERS

- Eliminate "wet jobs"
- Save fluid
- Protect formation

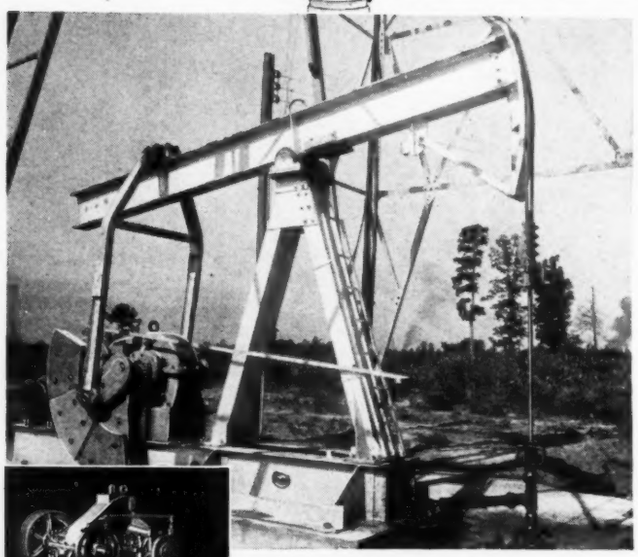


AXELSON MANUFACTURING CO.
P.O. Box 710, Vernon Station, Los Angeles, Cal.
Tulsa 50 Church St., New York St. Louis
Mid-Continent and Eastern Representative:
FRICK-REID SUPPLY CORPORATION
Rocky Mountain Distributor:
GREAT NORTHERN TOOL & SUPPLY CO.

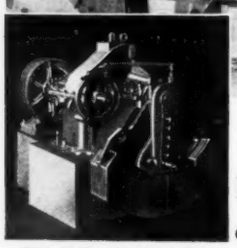
SPERRY-SUN WELL SURVEYING CO.
1608 WALNUT STREET, PHILADELPHIA, PA.
DALLAS, TYLER AND HOUSTON, TEXAS. TULSA, OKLAHOMA AND LOS ANGELES, CALIFORNIA
SURWEL (Gyroscopic) • SYFO (Ink Bottle)
UNDERGROUND WELL SURVEYING SERVICE

Renew Your Subscription..Now

When the PRESSURE fails will you be ready to PUMP?



IDECO A-3 *Geared Twin-Crank Pumping Unit*



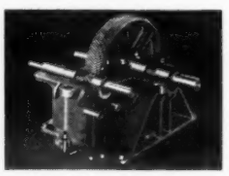
HM 67 Single-Crank Unit

BE PREPARED with compact, portable IDECOS

ARE you looking for *real* pumping performance? Then investigate these sturdy, portable, self-contained geared pumping units by IDECO! Built in twin-crank and single-crank types, with horse power capacities from 25 up, they offer you a complete range of the most reliable and economical pumping equipment you can select.

From base to beam they're built for service. Heavy steel for strength and stamina. Positively lubricated gears and shafts that defy wear. No skimping on material or fine workmanship. No oversights in engineering. No hidden weaknesses that might cause expensive shut-downs.

You can find no sturdier, more efficient pumping units at any price than these IDECO Geared Pumps. Time-tested and field-proved in every part of the world. When the pressure fails, BE READY with IDECOS.



Herringbone Steel Gears

Write our nearest branch for IDECO *Bulletin No. 100-D*

THE INTERNATIONAL DERRICK & EQUIPMENT CO.

Branches in all leading oil centers. *Factories* at Beaumont, Texas; Los Angeles, Calif.; Columbus, Ohio; Marietta, Ohio

Crown Blocks
Derricks
Drawworks
Float Shoes and Collars
Rotaries
Swivels
Traveling Blocks
Jars
Pitmans *(Steel)*
Standard Steel Rigs
Walking Beams
Bailing Reels
Geared Pumping Units
Rotary Counterbalances
Chain
Bailers
Wheels
Casing Blocks
Drilling Machines

BOYKIN IDECO

INDEX *to* ADVERTISERS

A

Abercrombie, J. S. Co.
American Cable Co. 16
American Hammered Piston Ring Co.
American Meter Co. 52
American Sheet & Tin Plate Co. 6
American Steel & Wire Co. 66
Armstrong Bros. Tool Co. 57
Axelson Manufacturing Co., Ltd. 78 and 79

B

Baroid Sales Co.
Bartlett Hayward Co., The
Biltmore Hotel 82
Bradford Motor Works 70
Bridgeport Matchine Company, The
Broderick & Bascom Rope Co.

C

Chaplin-Fulton Mfg. Co., The 82
Continental Supply Co., The 50
Cooper-Bessemer Corporation, The 51
Crane Co. 59

D

Dresser, S. R., Mfg. Co. 64

E

Eagle-Picher Lead Company, The 3
Electric Controller & Mfg. Co., The
Ethyl Gasoline Corporation 34 and 35

G

Gaso Pump & Burner Mfg. Co. 33
General Electric Co.

H

Hazard Wire Rope Co.
Hughes Tool Co. Back Cover
Hydrauger Corp., Ltd. 79

I

International Derrick & Equipment Co. 84
International Harvester Company of America 55
International Petroleum Exposition 4

J

Jones & Laughlin Steel Corporation 1
Jones, S. M., Co., The 75

K

Kobe, Inc. 83

L

Landis Machine Co., Inc.
Leschen, A., & Sons, Rope Co. 8
Linde Air Products Co. 15
Lufkin Foundry & Machine Company 40 and 41
Lufkin Rule Co. 74

M

Magnolia Petroleum Co. 76
Martin-Decker Development Co., Ltd.
Mason-Neilan Regulator Co. 76
Metric Metal Works 6
Merco-Nordstrom Valve Co.
Mepham, Geo. S., & Co.
Moore, Lee C., & Co. Front Cover

N

National Supply Companies, The 2
National Tube Co. 37
National Tube Co. (Stainless)

O

Oil Well Supply Co. 11
Oklahoma Gas & Electric Co. 60

P

Petroleum Rectifying Co. 5
Pittsburgh Equitable Meter Co.

R

Reed Roller Bit Company
Republic Steel Corporation 67 and 68
Ridge Tool Co., The 74

S

South Chester Tube Co. 46
Sperry-Sun Well Surveying Co. 83
Sullivan Co., The 83

T

Texas Power & Light Co. 73
Toledo Pipe Threading Machine Co., The 71
Tretolite Company Inside Front Cover
Trimont Mfg. Co.

U

Union Carbide & Carbon Corp. 15
Union Wire Rope Corp. Inside Back Cover

W

Wickwire Spencer Steel Company 43

Y

Youngstown Sheet & Tube Co. 49